Vol. IV.—No. 18.] [SEPTEMBER, 1880.

# THE MINERALOGICAL MAGAZINE

AND

# JOURNAL

OF THE

# Mineralogical Society

OF

## GREAT BRITAIN & IRELAND

*INSTITUTED 3rd FEBRUARY*, 1876.

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1880.

# PROCEEDINGS

OF THE

# MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND.

1880.

## EXCERPT MINUTES OF COUNCIL MEETING

*Held in the University of Edinburgh, April 5th,* 1880.

Prof. M. F. Heddle, F.R.S.E., *President,* in the Chair.

Professor F. J. Wiik, of Helsingfors, and Mr. Richard Pearce, of Denver City, Colorado, were elected as Ordinary Members.

## ORDINARY MEETING.

*Held in the University of Edinburgh, April 5th,* 1880

(By permission of the *Senatus Academicus.*)

Prof. M. F. Heddle, F.R.S.E., in the Chair.

Prof. A. Geikie, F.R.S., read a paper "On the microscopic structure of some vitreous basalts." The paper was beautifully illustrated by diagrams, and by a series of large coloured drawings—the work of the author.

Mr. J. B. Hannay, F.C.S., gave an account of his experiments with a view to the production of artificial diamonds, and exhibited some fragments of the diamonds produced.

The authors were thanked for their respective papers.

## LOCAL MEETING.

*Held at Dundee, in the Albert Hall, Friday, April 9th,* 1880.

Prof. M. F. Heddle, F.R.S.E., in the Chair.

Dr. Heddle gave an address in which he dwelt on the origin of mineralogical research in Scotland. He then described the steps which led to the formation of the Mineralogical Society, and gave an outline of the mineralogy of the neighbourhood of Dundee.

The Rev. W. W. Peyton, of Broughty Ferry, was elected Loc Secretary for the Central District of Scotland, in accordance with Ru 24.

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## EXCERPT MINUTES OF COUNCIL MEETING.

*Held at the Meteorological Office*, 116, *Victoria Street, London, S.W., June 1st*, 1880.

Prof. T. G. Bonney, F.R.S., *Vice-President*, in the Chair.

The Secretary reported the deaths of Professor Sismonda, Rev. Clifton Ward, F.G.S., and Professor Ansted, F.R.S., members of th Society.

The Secretary reported that the Rev. W. W. Peyton had been elect Local Secretary for the central district of Scotland, at a meeting Scotch members held in the Albert Hall, Dundee, on the 9th April, accordance with Rule 24; and the election was confirmed by th Council.

Messrs. Wm. Neish Walker, F.G.S., of Newport, Fife; Alexand Murray, F.G.S., of St. John's, Newfoundland, Director of the Geo Survey of N.F.; Geo. S. Mackenzie, Ph. D. of Dundee; and Hjalm Furuhjelm, of Helsingfors, Gov. Inspector of Mines for Finland, we elected as Ordinary Members of the Society.

Mr. Robert M. Heddle, of St. Andrews, was elected as an associat

The Balance Sheet and Statement of Assets and Liabilities as he appended, was presented by the Secretary, and adopted.

The Annual Meeting was fixed for the month of August, to be he at Swansea during the Meeting of the British Association.

It was resolved to recommend the re-election of all the officers, an to propose Prof. Church and Messrs. T. W. Danby, J. S. Merry, an J. F. Walker, as members of Council in place of the four retirin members, Messrs. T. Davies, T. M. Hall, M. H. Johnson, and D Oxland.

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## GENERAL MEETING.

*Held at* 116, *Victoria Street, June 1st*, 1880.

Professor T. G. Bonney, F.R.S., *Vice-President*, in the Chair.

The following papers were read :—

"On a new face on crystals of Stilbite from Scotland and Weste Australia," by Prof. M. F. Heddle, F.R.S.E.

"On a portable chemical cabinet for quantitative work," by A. Arnold, communicated by J. H. Collins.

"On kaolinite and kaolin," by J. H. Collins, F.G.S.

"On some substances which may prove to be new minerals," by Prof. M. F. Heddle, F.R.S.E.

"Further notes on mineral growth at ordinary temperatures," by T. A. Readwin, F.G.S.

Mr. F. W. Rudler exhibited a very large crystal of enstatite and a specimen of the new mineral Herrengrundite.

Mr. Semmons exhibited a specimen of Linnæite associated with Millerite in a nodule of clay iron-stone from the Rhondda Valley. The occurrence of Linnæite in this locality and association was first observed by Mr. Wm. Terril of Swansea.

Mr. J. R. Gregory exhibited part of a fine meteorite which fell at Esterville, Emmet Co., Iowa, U.S.A., on the 10th May, 1879.

Votes of thanks were passed to the authors of the papers read, to the Vice-President for his conduct of the Meeting, and to Mr. R. H. Scott, F.R.S., for the use of the room in which the meeting was held.

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List of Books Received from March to June, 1880.

From *The Dundee Naturalists' Society, Dundee.*
Reports, 1877 to 1879.
Catalogue of 3rd Exhibition.

From *Reale Comitato Geologico, Rome.*
Bolletino, 1 to 4, 1880.

From *J. P. Howley, St. John's, Newfoundland.*
The Geology of Newfoundland, by J. P. H.

From *Prof. Groth, Strasburg.*
Zeitschrift fur Kryst. und. Min., IV, 4.

From *Prof. Dana, Newhaven.*
American Journ. Science, April to June, 1880.

From *Soc. Min. de France, Paris.*
Bulletin III, 3 to 5, vol. III.

From *Prof. Tschermak, Vienna.*
Min. und. Pet. Mittheilungen, II, 6.

From *Soc. Toscan di Scienze Naturali Pisa.*
Procesi verbali pp. 37-52.

From *M. Emile Bertrand, Paris,*
Proprietés optiquès de la Brochantite, by E. B.

From *Prof. Kjerulf. Christiania.*
Die Geologie des Sudlichen und Mittleren Norwegen, by T. K.

From *M. Delesse, Paris.*
Carte Agronomique du Dep. de Seine, et Marne, by M.D.

From *Academy of Nat. Sciences, Philadelphia.*
Proceedings I, II, III, 1879.

From *Soc. Cientifica Argentina, Buenos Ayres.*
Anales, April, 1880.

*Anonymous*—Sitzungberichte der koniglichbayer Akad. der Wissenschaften, March 20, 1880, with obituary notices of Dové, Lamont, Mohr, Griesebach, Cotta, and Brandt.

## STATEMENT OF RECEIPTS AND EXPENDITURE TO DECEMBER, 31st, 1879.

### RECEIPTS.

| Dr. | £ | s. | d. |
|---|---|---|---|
| By Balances from 1878 ... ... ... ... ... ... ... | 54 | 18 | 5 |
| ,, Composition Fee ... ... ... ... ... ... ... ... | 10 | 10 | 0 |
| ,, Subscriptions for 1879 ... ... ... ... ... ... ... | 86 | 13 | 0 |
| ,, ,, Arrears ... ... ... ... ... ... ... | 36 | 4 | 0 |
| ,, Magazines sold ... ... ... ... ... ... ... ... | 15 | 8 | 0 |
| ,, Dividends on Investments ... ... ... ... ... ... | 3 | 10 | 6 |
| | £207 | 3 | 11 |

### EXPENDITURE.

| Cr. | £ | s. | d. |
|---|---|---|---|
| To Lake & Lake, for Printing Magazines, &c. ... ... | 72 | 3 | 6 |
| ,, Carriage of Parcels, Postage, &c. ... ... ... ... | 6 | 4 | 2 |
| ,, Postage of Magazines ... ... ... ... ... ... ... | 6 | 7 | 7 |
| ,, Travelling Expenses ... ... ... ... ... ... ... | 19 | 15 | 0 |
| ,, Clerical work and sundries ... ... ... ... ... ... | 3 | 6 | 6 |
| ,, Meeting Expenses ... ... ... ... ... ... ... ... | 1 | 16 | 0 |
| ,, Letcher, for case of Shelves ... ... ... ... ... ... | 2 | 15 | 0 |
| ,, Printing and Stationery ... ... ... ... ... ... | 10 | 4 | 0 |
| ,, Editing Magazine ... ... ... ... ... ... ... ... | 20 | 0 | 0 |
| ,, Investments 3 p.c. Consols ... ... ... ... ... ... | 23 | 10 | 6 |
| Balance ... ... ... ... ... | 41 | 1 | 8 |
| | £207 | 3 | 11 |

Examined and found correct
March 23rd, 1880.

BENEDICT KITTO.
F. W. RUDLER.

### ASSETS.

| | £ | s. | d. |
|---|---|---|---|
| Balance ... ... ... ... ... ... ... | 41 | 1 | 8 |
| Subscriptions (considered good) ... ... ... ... | 50 | 0 | 0 |
| Due for Magazines and Maps sold ... ... ... | 12 | 12 | 5 |
| Estimated value of Stock, 1-3rd selling price ... ... | 122 | 0 | 10 |
| | £225 | 14 | 11 |

### LIABILITIES.

| | £ | s. | d. |
|---|---|---|---|
| Lake and Lake, for Map ... ... ... ... ... | 64 | 11 | 3 |
| Do. for Magazines ... ... ... ... ... | 64 | 19 | 0 |
| Sundry Bills (estimated) ... ... ... ... ... | 5 | 0 | 0 |
| Balance ... ... ... ... ... | 91 | 4 | 8 |
| | £225 | 14 | 11 |

### TRUST ACCOUNT, DECEMBER 31st, 1879.

| | | | |
|---|---|---|---|
| 3 per cents Consols ... ... ... ... ... ... | £118 | 3 | 0 |
| Investment of £23 10s. 6d. ... ... ... ... ... | 24 | 10 | 2 |
| | £142 | 13 | 2 |

*(Signed)* P. DUDGEON, for self and Co-Trustee.

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MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

No. 18. SEPTEMBER, 1880. Vol. IV.

## VI.—*On Portable Chemical Apparatus for Quantitative Mineral Analysis.*

By A. E. Arnold.

Communicated by J. H. Collins.

TOWARDS the end of the last century one Professor Göttling, who taught chemistry in the schools of Jena, conceived the idea of preparing a portable chest of chemistry, or complete collection of Chemical Tests.* Chemical knowledge being in those days somewhat limited, we are not surprised to find that the contents of the chest could be stowed within a space nine inches square by twelve deep.

This cosmopolitan collection was intended for the use of chemists, physicians, mineralogists, scientific artists, manufacturers, farmers, and the cultivators of natural philosophy. The tests were prepared by a Mr. Hunneman, a friend of the author, and pupil of Klaproth and Hermbstaedt of Berlin; and were put up in thirty five glass bottles and some small wooden boxes.

The tests, such as they are, are in general of a reliable nature, and in accordance with the state of chemistry at that time; but neither chemists,

* A copy of the small treatise which accompanied the collection, and which formerly belonged to Faraday, is now in the Library of the Chemical Society The English version was published in 1791 in London, and was sold by Messrs. C. and G. Kearsleys, No. 46 Fleet Street, who also supplied the chests.

farmers, nor natural philosophers would derive much practical benefit from their application in this present generation.

The cabinet which I shall presently describe is principally intended for the use of mineralogical chemists, or persons who, having some knowledge of analytical chemistry, are familiar with the appearances presented by the crystalline and non-geometric but distinctive forms, which most common minerals possess. Those minerals also which occur in amorphous masses, in which it is impossible to detect a determinate crystalline shape, but which are technically of the greatest importance, can likewise be usually discriminated by their colour, lustre, hardness, density, &c. It is proposed, if possible, to supply minute directions with the cabinet, by the use of which careful persons, other than these, may arrive at reliable results.

In Professor Göttling's little book, there is no attempt at anything beyond qualitative description. To find out whether a piece of mineral was iron or copper ore, whether a liquid was acid or alkaline, whether a rock was fusible or infusible—these and similar questions are all that it attempted to decide. In fact at that time the attention of scientific men was more bent upon qualitative than quantitative inquiry. To know of what substances the earth is made* occupied their minds more than the question, 'In what proportions are these substances allied to each other?' The discovery that a certain kind of rock contained copper, and that another kind of rock contained lead, were facts of greater significance to them than to us. The merchant and manufacturer now pay little or no attention to such results as these; the information they desire to obtain is of a quantitative character. The percentage of the valuable constituent and the quantity of the deleterious constituent or constituents are the items upon which they calculate. For example, the merchant now guarantees under penalty of forfeit that a cargo of Hematite shall contain at least (say) 55 p.c. of iron and not more than 0·10 p.c. of phosphoric acid, Inasmuch as he knows that all iron ores contain iron and phosphoric acid, a qualitative examination is useless to him. Commercial transactions have been based upon the accurate determination to 0·01 p.c. of iron in a given sample: this it is acknowledged is drawing the line far too fine, but the tendency to scientific exactitude prevalent of late years marks a new era in Commercial Technology.

* Cronstedt's Mineralogy, which appeared in English in 1770, was the first systematic work in this field. He does not give any quantitative relations; neither does he mention in the attached description of a pocket laboratory, any attempt at quantitative estimations. Gustavus von Engestroem and Bergman wrote descriptive treatises upon pocket laboratories soon after Cronstedt's; but the discrimination of different substances occupied their sole attention.

Notwithstanding the repeated attempts made since Cronstedt's time to roduce chemical cabinets which should be of value to the scientific aveller, Plattner was the first to work out* (1853) the means by which miniature Laboratory of this nature could be rendered capable of erforming accurate quantitative determinations. The patience and inute care which he bestowed upon the subject are too well known by nembers of this society to need mention here. He placed in the hands of hemists and mineralogists a portable cabinet which enabled them to etermine the amount of silver, mercury, copper, tin, and iron present in inerals containing them. Of the processes described in his book that or the estimations of silver was capable of giving the most accurate esults, and remains a monument of his skilful handicraft. We can owever estimate copper and iron with much more accuracy than his rocesses permit of, by means of Volumetric Analysis. There are only two r three minerals of commercial importance of which the valuation made ccording to Plattner would avail commercially.† We must not forget owever that Plattner's cabinet is mainly a metallurgical one, and that the stimations stand comparison better with metallurgical than with chemical ssays: nearly all the determinations are done by the blowpipe, and wet nethods are only introduced in a few instances. Ores of iron and zinc, f lead and manganese, cannot be valued by means of the blowpipe.

I have not yet been able to find any account of a portable chemical abinet of appliances specially designed for, and shown to be able to erform the valuation of those common metals which are technically of he first importance. Nor am I aware that such a cabinet can be obtained n this country, or indeed abroad. My friend Mr. Collins tells me that he as felt the want of a cabinet which is neither a toy collection nor a set f lecture table apparatus. A few months since, being in expectation of naking a visit to Servia, I worked at the processes about to be given with n idea of constructing a cabinet useful for the purposes of mining esearch.

Under what circumstances does the analytical chemist travelling abroad pon a mineral survey, pursue his vocation? He is usually away from the

* The previous work of Berzelius (1820) and of Harkort (1827) contributed, however, o Plattner's success.

† I do not wish in any way to undervalue the excellent work that is done all over the orld by means of the blowpipe. A pocket case is of great service in the field, and nables the mineralogist to discriminate between valuable and non-valuable minerals in number of instances: that is to say, between those which are worth and those which re not worth more accurate chemical investigation. While acknowledging the importance f Blowpipe Chemistry, I cannot acknowledge that it fulfils the requirements of tech- ology in an adequate manner. Plattner's complete cabinet of Blowpipe apparatus sold n this country at 30 guineas, does not suffice for the scientific valuation of ores of the ommon metals.

vicinity of towns,—never, however far from some small village. Here h sojourns while making incursions into the surrounding country. Afte collecting his specimens he returns to the village and takes the firs opportunity of making some determinations. Distilled water is not to b obtained unless the village apothecary has a still, and can be induced t use it; our chemist cannot burden himself by taking a sufficient supply Kettles among non-tea-drinking people in the south of Europe are ver rare; and should he succeed in obtaining one and concocting a condense his work would still be considerably delayed. Therefore he must be conten to use the common water of the place, which if it gave a considerabl precipitate with ammonia oxalate it might be advisable to boil and filter By the system I adopt, however, common water may be used withou purification. Provided that the water is fairly free from iron and sus pended matter, a condition generally fulfilled, it may be used in the estima tion of the constituents enumerated in the subjoined scheme of analysis. have found a difficulty with the sulphur estimation: until that is satis factorily overcome our chemist must wait for the wet season.

Another difficulty in out of the way places is to provide the sourc from which heat is derived. Gas is of course out of the questio In Italy and Spain there may sometimes be found among the culinar arrangements of the household, small round charcoal furnaces built i brick which are useful to heat an iron plate. But as a rule no casua sources of heat such as this should be relied upon. Oil can easily b obtained in the south of Europe, and need not form an item of th collection. It is burnt in an Argand lamp placed underneath an iro plate six inches in diameter. This serves to heat flasks and beakers to boil water, and to evaporate liquids contained in small Berlin dishes which are supported on the plate by tinned iron rings. A spirit lamp i used to ignite crucibles, &c. A flask of spirit is carried in the case, and the flask can be replenished in towns. Another Argand lamp heats a small air bath, the top-plate of which can be used for precipitation and slow evaporations. A Plattner's Blowpipe lamp is fed with equal volumes of oil and alcohol. Pisani recommends a mixture of six volumes of spirits of wine and one of oil of turpentine, to which is added several drops of ether. He found that this liquid gave a bright flame, and evolved no unpleasant odour, its heating power when urged by the blow-pipe was sufficient to fuse the end of a platinum wire 0·2 mm. in diameter, and to melt an iron wire of 0·3 mm. in diameter into a globule of a millimetre in radius. He was also able to melt 23 grams of silver, and to cupel 5 grams. of argentiferous lead by its means.

We now come to consider the nature of the processes employed. The principle upon which they are worked out lies in the employment of $\frac{1}{10}$th

of the quantity of substance usually operated upon, and both re-agents and appliances are similarly arranged in miniature. The centner of 100 mg. was first I believe used by Plattner, and this is the quantity of mineral which is used in the estimations. Gravimetric determinations are avoided where practicable, and volumetric processes supply their place. The greatest objection to such a course of procedure is that the eye is not as delicate in discriminating end reactions as the operator might wish. My own power of discriminating tints is rather below than above the average. I think I may state however, that determinations of the common metals may be made without the error exceeding 1 p.c. of the substance operated upon. I think I may go further;—if 100 milligrams of mineral be taken—such minerals for example as calamine, hematite, copper pyrites, carbonate of lead, chromic iron,—the variation from the truth which careful determinations will exhibit will not exceed 0·5 mg. and will be frequently considerably closer.

The estimations which are of most importance in the valuation of minerals for commercial purposes may be given as follows:—

1. Iron ores—iron, phosphoric acid, silicious residue.
2. Manganiferous iron ores—manganese in addition to the above.
3. Chrome iron ores—chromium.
4. Manganese ores—manganese peroxide and manganese.
5. Copper ores—copper.
6. Lead ores—lead and silver.
7. Zinc ores—zinc.
8. Cassiterite—tin, iron, silicious matter.
9. Cobalt ore—cobalt protoxide.
10. Antimony ore—antimony.
11. Mineral phosphates—phosphate of lime ($Ca_3\ P_2\ O_8$).

### (1.) Iron Ores.

The iron is measured volumetrically by bichromate of potassium. The standard solution is made so that 1 c.c. shall equal 4 mg. of iron. As the bichromate can be obtained nearly pure in the shops, by taking the theoretical quantity, the right standard is very nearly obtained. Theoretically 1·758 grams. should be dissolved in half a litre of water; the solution then oxidizing 4·000 mg. of iron per c.c. As a mean of two results 1.756 gram. was required in practice; another sample of bichromate gave 1·754 gram. The purity of the salt however must not be relied upon, and in this case as in every other the true value of the standard liquid must be found by direct titration.

The spotting is done with a very dilute solution of potassium ferricyanide, a drop of which should give but a faint tinge of yellow when

placed on the porcelain plate. The acid solution of iron-chloride after complete reduction by zinc, is carefully and rapidly turned into a small Berlin dish, and titrated. It should not measure more than 20—30 c.c. including the washings of the flask. When the end reaction appears on the plate a little ferricyanide is run into the dish by means of a fine piece of glass tube, the same in fact with which the spotting on the plate is done. A green coloration denotes that a drop or two more bichromate is required; a whitish or yellowish coloration shows when the reaction point is reached.

With the burettes used one drop is sufficient to produce the final change in a definite and recognizable manner. The drops let fall by the burettes weigh about 27 mg. and correspond to 1·1 decimilligram of iron or 0·11 p.c. upon a centner of 100 mg. of iron ore. The burette used is an ordinary 20 c.c. Mohr. and its readings are correct to within 0·02 cubic centimetre.

Each cubic centimetre is divided into 10 parts, and each part is again divided into 10 by the eye, this can be done after a little practice with ease and accuracy. One hundredth of a cubic centimetre is thus read off, and as there are 37 drops of 27 mg. each in 1 c.c., a fraction of a drop may be measured. This is, however, usually unnecessary. Under these circumstances the following results were obtained with fine-drawn soft iron wire; the wire contains 99·8% of iron, a constant by which the weight of iron taken is multiplied.

1 c.c. Bichromate = 4·000 mg. iron.

| | *Iron wire taken.* | *Equal to Pure Iron.* | *c.c. of* $K_2 Cr_2 O_7$. | *Iron found.* |
|---|---|---|---|---|
| A | 70·0 mg. | 63·9 mg. | 17·54 c.c. | 70·16 mg. |
| B | 79·0 ,, | 78·8 ,, | 19·71 ,, | 78·84 ,, |
| C | 61·8 ,, | 61·7 ,, | 15·40 ,, | 61·60 ,, |
| *D | 49·64 ,, | 49·64 ,, | 12·41 ,, | 49·64 ,, |

A sample of micaceous iron ore was next operated upon. My friend Mr. W. E. Dawson determined the iron in this ore in the ordinary manner, and found it to amount to 62·33 p.c. I may state that as a rule my results are slightly higher than his owing, to a slight difference made in judging the final reaction. Five centners (or 500 mg.) of the dried ore were dissolved in hydrochloric acid, the liquid was diluted and filtered into a 50 c.c. measuring flask.

A. 10 c.c. (= 100 mg. taken) took 15·64 c.c. $K_2 Cr_2 O_7$ = 62·56 p.c.
B. 10 ,, ,, ,, 15·65 ,, ,, = 62·60 p.c.

*5 c.c. of a standard sol. of $FeSO_4$ were taken, 50 c.c. of which solution was known to contain 0·4964 gm. iron as $FeSO_4$.

The solution of ferric chloride is reduced with pure re-distilled zinc. his can be obtained in Germany at about 6 marks a kilo. The reduction conducted in a small flask on an iron plate, the flask being covered th a watch glass; or a test tube may be used.

*Phosphoric Acid.*—This estimation can be effected with accuracy by eighing the phospho-molybdate precipitate obtained from 5 centners of e. The errors when the operation is conducted in accordance with the inciples observed by persons of experience does not exceed 0·01 p.c. ie precipitation is conducted at a temperature of from 50°—60°C; the ole bulk of liquid not exceeding 30c. c. Five centners of ore containing 05 p.c. of phosphoric acid gives a precipitate weighing 7·5 mg. which n be weighed to a fraction. Boussingault's constant of 0·0373 is used deduce the phosphoric acid; 0·01 p.c $P_2O_5$ should be added for loss and ubility. The yellow precipitate, it should be mentioned, is washed off e filter into a small platinum dish in which it is dried on the iron plate d afterwards weighed.

*Silicious Residue.*—This determination is made gravimetrically in the linary manner upon 500 to 1000 mg. of ore, the filtrate from which is ed for the other estimations. The results agree to within 0·2—0·3 p.c. e silica in the residue can be determined by fusion. The silicious idue should be determined *after evaporation to dryness*, and so stated.

If it is important to notice if an ore is calcareous or silicious in nature, ough indication may be obtained by observing if the addition of an acid duces a strong evolution of carbonic acid.

### (2.) Manganese Peroxide.

This is estimated in Pyrolusite, &c., by boiling about 200 mg. of the weighed in a small glass tube in acidulated ferrous sulphate solution; 00 mg. of cryst. ferrous sulphate is dissolved in a hot boiled 10 p.c. phuric acid solution in a flask, the tube containing the manganese is efully dropt in after decomposition, the liquid is titrated with chromate. Ferrous sulphate is taken to contain $\frac{1}{5}$ of its weight of iron; lind it to be more exact than taking the theoretical figure. A blank ay was made without putting the manganese into the flask, the liquid ng boiled for a $\frac{1}{4}$ hour by itself. It yielded the following results: iron en 44·44 mg., iron found 44·44 mg.

### *Manganese.*

Metallic manganese is estimated with accuracy by Pattinson's method J. Chem. Soc. June 1879, p. 365), upon 100 mg. of ore. Every ticular has to be conducted upon the miniature scale adopted in this tem of analysis. The ore is dissolved in a flask with a few cubic

centimetres of hydrochloric acid, and about 100 mg. of anhydrous ferr chloride is added after the excess of acid has evaporated, and 10 or 15 c. of water has been added. The liquid is now neutralized with chall until a slight precipitate falls, ten c.c. of a clear solution of bleachin powder are now added and 50—60 c.c. of boiling water; the liquid immediately neutralised with 250 mg. of chalk and well stirred; it shoul be placed on the hot iron plate for a few minutes but not boiled. Th flocculent precipitate is brought upon a filter and washed until the wash ings are shown to be free from chlorine by a drop of potassium iodide an starch. The filtrate must be pink; 0·10 p.c. of manganese is added f the manganese converted into permanganate, which is lost. While this going on, 600 mg. of ferrous sulphate crystals are accurately weighed and dissolved in 50 c.c. of hot 10 p.c. (vol.) solution of sulphuric acid The filter with its contents is placed in a small dish, the ferrous sulpha is poured upon it, and, after stirring, the liquid is titrated with bichroma The constant from Fe found to Mn wanted is 0·491. In manganifer iron ores ferric chloride is not wanted. A manganese ore gave

Manganese present 47·39 p.c. Manganese found 46·73 p.c.

### (3.) Copper.

De Haen's method is used, but the iodine solution is dispensed wit The copper is separated from the ore as sulphide by boiling the sulphu acid solution with sodic hyposulphite. The sulphide is roasted in porcelain crucible, and treated with hydrochloric and a few drops of nitri acid. After evaporation it is treated with sodic acetate and one gram. potassium iodide, and the copper estimated with hyposulphite and starch The hyposulphite solution is made so that 1 c.c. = 1·0 mg. of copper, bu this standard will decrease,* and must be tested every few weeks wit pure copper.

A standard solution was made from a stronger solution, the titre o which was known. A standard solution of pure copper was made, 5 c.c. of which contained 25·25 mg. of copper:

1 c.c. hyp. = 1·000 mg. copper.

| *Copper taken.* | *c.c. taken.* | *Copper found.* |
|---|---|---|
| 25·25 mg. | 25·1 c.c. | 25·1 mg. |
| 25·25 ,, | 25·3 ,, | 25·3 ,, |
| 25·25 ,, | 25·25 ,, | 25·25 ,, |
| 25·25 ,, | 25·5 ,, | 25·5 ,, |
| 25·25 ,, | 25·5 ,, | 25·5 ,, |
| Mean 25·25 | 25·33 c.c. | 25·33 mg. |

Ammonium carbonate (1 grm.) is added to preserve this solution.

I think I may therefore assert that the copper estimation can be made within 0·5 p.c. of the truth. For the whole of the copper present in the ore is completely separated by hyposulphite of sodium sulphuric acid solution, and the substances which may possibly contaminate the precipitate do not interfere with the reactions. If the analysis of very rich ores is contemplated, the hyposulphite solution should be twice as strong.

### (4.) Silver.

Silver is estimated metallurgically according to the directions of Plattner, the blowpipe apparatus commonly used is therefore included in the cabinet.

### (5.) Lead.

There is a volumetric method for the estimation of lead by precipitation as chromate, and the subsequent titration of the chromic acid set free by sulphuric acid from the isolated salt. This method can be applied to all lead minerals, is rapid, and yields fairly accurate results. Carbonates of lead are dissolved in nitric acid, sodic acetate is added and then potassium bichromate; the lead chromate deposits at a gentle heat and can be filtered and washed with rapidity with galena; where the nitric acid produces sulphate of lead, the bases in the solution are converted into sulphates, and the sulphate of lead, &c., is filtered as usual. This latter is converted into carbonate of lead by digestion with carbonate of soda, the precipitate is filtered off, dissolved in acetic acid, and treated with potassium chromate.

In operating with small quantities I have found that sulphuric acid does not set free the whole of the chromic acid. Small quantities of undecomposed chromate may be seen by the eye. The following experiments establish this fact; 50·0 mg. of pure lead was precipitated from as acetic acid solution as chromate. The chromate of lead after filtration was placed in a dish together with its filter, and an excess of ferrous sulphate together with dilute sulphuric acid was added to it. The whole was boiled for some minutes, but traces of chromate of lead were still visible. It was then titrated by bichromate (4·000 mg.) of which it took 2·52 c.c. (=10·08 mg. Fe). The ferrous sulphate taken corresponded to 49·6 mg. iron. Therefore $49{\cdot}6 - 10{\cdot}08 = 39{\cdot}52$ mg. iron, which, multiplied by the constant for deducing lead from iron: gives— $39{\cdot}52 \times 1{\cdot}232 = 48{\cdot}7$ mg. of lead found, instead of 50·0 mg. taken. Another experiment gave 47·2 mg. instead of 50·0 mg. In order to obviate these important errors, another course was finally adopted. The amount of chromic acid in solution after the lead had precipitated was determined. To the acetic acid solution of lead 14·95 c.c. of bichromate

solution was added; the liquid was warmed and filtered. To this filtra 49·6 mg. of iron, in the form of ferrous salt was added. The excess ferrous salt took 7·53 c.c. of bichromate.

$14{\cdot}95 \times 7{\cdot}53$ c.c. $= 22{\cdot}48$ c.c. $K_2Cr_2O_7 \times 4{\cdot}000 = 89{\cdot}92$ mg. iron
Iron in ferrous salt used $= 49{\cdot}60$ ,, ,,

Chromic acid withdrawn by lead $= 40{\cdot}32$ ,, ,,

To deduce lead: $40{\cdot}32 \times 1{\cdot}232 = 49{\cdot}67$ mg. lead found, instead of 50 mg. of lead taken.

Four burette readings of bichromate were taken in this experimen and the error of the estimation was 0·33 mg. lead. This corresponds 0·07 c.c. of the burette. The error of a reading need not amount more than 0·02 c.c., and therefore since these errors would not exter always in the same direction, the burette measurements need not introd any serious source of error.

### (6.) Zinc.

If sulphide of zinc could be washed without loss, this metal might advantageously determined by ferric chloride and bichromate. But t foregoing is a difficulty which renders the process useless to the pract assayer. The best results I obtained exhibited considerable deviat from the amounts of zinc taken, owing to this source of error, example:—

| *Zinc taken.* | *Bichromate taken.* | *Zinc found.* |
|---|---|---|
| 20·0 mg. | 9·03 c.c. | 21·0 mg. |

Schaffner's process was found to be impracticable with small quantities substance; the same may be said of the ferricyanide and iodine meth Fairly good results were obtained with potassium ferrocyanide in hyd chloric acid solution, using uranium as indicator; and I consider t method to be reliable, and more applicable to the estimation of sm quantities of zinc than any other with which I am acquainted.

Potassium ferrocyanide like potassium bichromate can be obtained England tolerably pure; a weighed quantity will therefore give a standa approaching the true one. The theoretical equivalent however must be taken, because the composition of the precipitate formed is established. To make a solution 1 cubic centimetre of which shall eq 2·00 mg. of zinc, 4·4 grams. of ferrocyanide should be dissolved in 500 c of water. Two separate samples of the salt were used to make t standard solutions, each equal to 2·00 mg. of zinc per cubic centimet in the one case 4·33 grams. ferrocyanide were required, and in the ot 4·42 grams.

The operator finds the standard of his solution by means of pure zi a stock of which he carries with him. The zinc is separated from

iron in the ore, &c., by double precipitation with ammonia. Manganese in quantity interferes with the accuracy of the results, but is not often present in calamine and blende. Copper if present is separated from the sulphuric acid solution by boiling with a gram. of sodium hyposulphite; after oxidizing any iron present, the liquid is precipitated by carbonate of soda, and evaporated somewhat in a porcelain dish, the precipitate is re-dissolved in a little hydrochloric acid after filtration, and the iron is separated by ammonia as usual. The bulk of the liquid before titration should not exceed 20—30 c.c.

The following results have been obtained:—

I. The standard solution was equal to 1·50 mg. zinc per c.c. known weights of pure zinc were taken.

| *Zinc taken.* | *c.c. taken.* | *Zinc found.* |
|---|---|---|
| 33·2 mg. | 22·0 c.c. | 33·0 mg. |
| 34·6 ,, | 23·0 ,, | 34·5 ,, |
| 34·6 ,, | 23·0 ,, | 34·5 ,, |
| 34·6 ,, | 23 6 ,, | 35·4 ,, |

The last result was produced in the presence of 5 c.c. concentrated hydrochloric acid, showing that considerable excess of acid must be avoided.

| *Zinc taken* | *c.c. taken* | *Zinc found* |
|---|---|---|
| 25·0 mg. | 16·8 c.c. | 25·2 mg. |
| 32·4 ,, | 21·9 ,, | 32·5 ,, |

II. Another standard solution of zinc (1c.c. = 2·58 mg.) was made. The following determination was made in acidulated ammonium chloride solution, to correspond with the actual testing.

| *Zinc taken* | *c.c. taken* | *Zinc found* |
|---|---|---|
| 40·0 mg. | 15·5 c.c. | 40·0 mg. |

In an acid solution containing no ammonium chloride two determinations gave.

| *Zinc taken* | *c.c. taken* | *Zinc found* |
|---|---|---|
| 40·0 mg. | 15·7 c.c. | 40·5 mg. |
| 20·0 mg. | 7·8 c.c. | 20·1 mg. |

The standard of the ferrocyanide should be determined in the presence of 0·5 to 1·0 gram. of ammonium chloride. In these experiments the reactions were distinguishable to within 0·2 c.c. Care *must* be taken that the ferrocyanide is run in a few c.c. at a time, with shaking. The testing must be continued until the addition of 0·2 c.c. from the last reaction produces, upon standing for a moment or so, a permanent deepening in the colour of the spot.

Zinc can be estimated in the manner described to within 1 p.c. of the true content of the ore. A correction of 0·5 p.c. might perhaps be added in the case of ores containing much iron or copper.

I have made a few estimations by this process in some complex metallic sulphides containing Blende from Sardinia, and obtained the following results.

| | *Gravimetric determinations.* | *Miniature Volumetric. Method.* | *Difference.* |
|---|---|---|---|
| Zinc .. .. .. | 24·54°/₀ | 24·63°/₀ | 0·09°/₀ |
| Zinc .. .. .. | 11·54 ,, | 11·86 ,, | 0·32 ,, |
| Zinc .. .. .. | 18·01 ,, | 18·38 ,, | 0·37 ,, |

(7) TIN.

Cassiterite is assayed by boiling 1 grm. of the mineral with strong hydrochloric acid to remove iron; in rich ores about 0·1 p.c. of tin oxide is rendered soluble by this operation. The insoluble residue is dried and fused under crude potassium cyanide in a small crucible. About a gram of ore should be taken, the principal source of error lies in uncertainty as to whether the whole of the tin has collected in the button: of two assays therefore the highest should be taken.

(8) COBALT.

Cobalt is estimated by boiling the mineral containing it with aqua-regia in a small conical flask: after evaporating the excess of acid the liquid is neutralized with sodium carbonate, and a hot concentrated solution of potassic acetate is added to precipitate the iron, arsenic acid, silica, &c. The filtrate is evaporated to 10 or 15 c.c. and 3 c.c. of a saturated solution of potassic nitrite rendered acid by acetic acid, is added. The cobalt nitrite is dried and weighed as usual. Two centners of ore are taken for the estimation.

(9) ANTIMONY.

One centner is boiled with aqua-regia; tartaric acid, ammonia and ammonium sulphide are added, and the liquid is filtered. Acetic acid precipitates arsenic and antimony in the filtrate. These are separated by Bunsen's method, using sodium sulphite acidulated with hydrochloric acid. The antimony is weighed as $Sb_2O_4$.

(10) PHOSPHATE OF LIME.

This estimation is made by uranium solution of which 1 c.c. = 2·0 mg. phosphoric acid.

To prepare the liquid to be titrated the following procedure is adopted. The sample is powdered, and ground in the agate mortar until soft to the

touch, *like flour*. Five centners are weighed, placed in a clean dish and mixed with cold 5 p.c. solution (volume) of dilute sulphuric acid, by triturating with a pestle; 20 c.c. of this acid suffices. The last few cubic centimetres are used to wash out the dish after the contents have been poured into a 50 c.c. flask; a little water may also be used. After standing for several hours, with occasional shaking the liquid is made up to the mark and 0·3 c.c. water added. The whole is filtered through a dry filter into a dry flask. Ten cubic centimetres (=100 mg.) are neutralized with carbonate of soda and made just acid with acetic acid; the titration is then proceeded with. Another 10 c.c. should be used to check the result. Some crystals of pure uneffloresced rhombic phosphate of soda are contained in the cabinet and are used to standardize the uranium solution. Of this salt 1·01 gram. is weighed off (after powdering and pressing between filter paper), dissolved in water and made up to 100 c.c. 10 c.c. of this liquid (=20 0 mg. $P_2O_5$) is placed in a flask, a few drops of carbonate of soda and finally of acetic acid are added (to acid reaction), and the liquid is titrated hot as usual.

A phosphate containing 35·86 p.c. of phosphoric acid was found to contain 35·99 p.c. $P_2O_5$ when working with a uranium solution 1 c.c. of which equalled 1·290 mg. $P_2O_5$.

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Having described the analytical methods adopted, we now come to consider the arrangements by means of which they are carried out.

For this purpose it will be convenient to consider these arrangements under four heads, namely;—

1. The measuring apparatus and standard solutions.
2. General apparatus for analytical work.
3. Chemicals, liquid and solid.
4. Cabinet arrangement.

### 1. *The measuring apparatus, &c.*

The balance is constructed with the special object of portability. It takes a maximum weight of 10 grams. and indicates accurately 0·0001 grams.—(one deci-milligram). A folding glass case is erected over it when in use and packs into the same box, occupying a space of about $8 \times 8 \times 3$ inches.

The burettes, two in number, are of Mohr's construction. They measure 20 c.c. of liquid, with a delicacy of measurement of within

$\frac{1}{50}$ c.c. They are supported by a brass upright 10 inches long which screws into the centre of a rectangular base. This base, or foot is half covered with a porcelain plate which is screwed into it. This serves for spot reactions. These burettes, their stand and appurtenances, are fitted exactly in a box 8 inches wide 15 inches long and 2 inches in external thickness. This box contains moreover six pipettes, one 10 c.c., one 5 c.c., two 2 c.c., and two 1 c.c. in capacity; the whole arrangement is independent, so to speak, of the rest of the cabinet.

Four standard solutions are carried in the case. Each bottle contains 500 c.c. of liquid, which seems to me to be the minimum quantity consistent with the objects in view. Potassium Bichromate, Potassium Ferrocyanide, Uranium Acetate, and Sodic Hyposulphite are found to be sufficient for most practical purposes. These bottles have well ground stoppers which are tied down by caoutchouc caps. Two more 500 c.c. bottles containing ammonia and hydrochloric acid are fastened down in like manner. The six bottles are contained in a drawer $10\frac{1}{2} \times 15 \times$ inches, in which the burette box likewise finds a place.

Four measuring flasks are provided, of respectively, 250, 200, 100 and 50 c.c. capacity. They are contained in a drawer of the same case.

### 2. *Apparatus.*

1. Plattner's blowpipe apparatus for cupellation; in separate case.

2. Platinum crucible and dish; platinum wire, and swing for crucibles; platinum forceps.

3. Six porcelain crucibles; six porcelain dishes for evaporation, (smallest size). One three inch porcelain dish for iron tests. Tinned ring supports.

4. Copper drying bath (hot air) with holes in top for basins, crucibles, &c.

5. Round iron plate (6-in). Iron wire gauze 1 sq. ft.

6. Heating apparatus. Two small argand burners for oil; a ring support slides on the brass upright. One spirit lamp: a tin can containing $\frac{1}{2}$ litre of spirit.

7. Beakers, 2 sets of three (small size). Flasks of 60-70 c.c. capacity, eight.

8. Funnels, assorted, six: close and open filter paper 12 packets.

9. Miscellaneous: test tubes, watch glasses, stirring rods &c.

10. Two washing bottles of 250 c.c. capacity, for hot and cold water.

### 3. *Chemicals (liquid and solid.)*

1. Six 250 c.c. glass bottles containing nitric, sulphuric, and acetic acids; ammonium sulphide, ammonia nitro-molybdate, and carbonate of soda, (solutions.)

2. Sixteen two ounce re-agent bottles containing ferrous sulphate, carbonate of soda, carbonate of lime, anhydrous ferric chloride, sodic phosphate, potassium dichromate, potassium ferrocyanide, potassium chlorate, sodic sulphite, potassic cyanide, bleaching powder, barium chloride, potassium nitrite, sodic acetate, potassium iodide and potassium ferricyanide.

3. In small turned wood boxes: starch, pure lead, electro-type copper, and litmus paper.

4. A bag of redistilled zinc, free from iron.

### 4. *Cabinet Arrangement.*

The aforesaid re-agents and appliances are contained in two cases of hard wood for the sake of portability. A strong leather handle is affixed to the top of each case so that it may be carried like an ordinary portmanteau. The cases are of the same size, viz. 13-in. deep, 17-in. high, and 17-in. in diameter (the depth is given at right angles to the height when the case is standing upright). The first case contains simply two drawers with partitions in which the burette box, the standard solutions, the flasks, and miscellaneous glass apparatus find their place.

The second case contains one drawer, the rest being open spaces, in which are stowed the balance, the blowpipe apparatus, the liquid and solid reagents, the heating apparatus and miscellanea. By these arrangements the cases are weighted as evenly as possible. Both cases are bound in green baize or leather and studded with brass nails.

N.B. The chests will be made by Messrs. E. Cetti & Co., of Holborn, the celebrated glass apparatus manufacturers.

## VII.—*Further Notes on Mineral Growth.*

By T. A. Readwin, F.G.S., M.R.I.A., &c.

WHEN I read my first paper on "Recent Mineral-growth a ordinary temperatures" under (what we, perhaps, rathe carelessly call) "ordinary conditions,"* I was met with the reasonab remark that, time enough had not elapsed for me to be *certain* o my facts.

Since then, I have had more than three years of affectionate watchin in my "Gold-garden" (as Mr. Ruskin pleasantly calls it); and I a glad to say that the interim has been productive of some new a striking spontaneous changes; which, for convenience of expressio I continue to term "mineral-growth."

I have before me a number of mineralogical facts of much intere and I propose to notice first, some recent alterations in 47 of t specimens described in the paper referred to; and then to add a fe short notes of similar changes in 35 specimens, not therein alluded t

On page 167 of the Mineralogical Magazine, vol. I, I describe son *Iron-growths* out of a specimen of Magnetic Iron-ore; cabinet numbe Fe 840. With this, I have associated another specimen (Fe 840*a*), portion of 840. These two bits of minerals are positively amusing as well as suggestive.

It happened on the 13th of May last, I had occasion to show the to the Hon. J. K Howard, at the office of Woods, Forests, &c., an then for the first time I noticed a broad protrusion about $\frac{3}{4}$ of a inch long, standing straight out, almost level with the bottom of th tray in which it now is.

On examination next morning the protrusion had disappeared. I had, somehow, got underneath the specimen, had flattened and attache itself again to it.

I then discovered that the protrusions (too many to count easily) would attract or repel one another.

I placed the two specimens upon the glass-top of the box, abou half-an-inch apart, when, presently the biggest bit drew the othe more than half-round in a second of time; the little one snatchin sundry protrusions from its big brother in transit. The little thin assumed a rough resemblance to the stuffed black baby-elephant at th

* Mineralogical Magazine, Vol. I.

British Museum, with partially hairy body and a proboscis-like protrusion, more than half-an-inch long.

I again put the larger piece about the same distance off, and it behaved in exactly the same way as my magnet.

On moving the big bit, the proboscis of the other invariably turned in its direction, prior to its bulk doing the same.

Some of the protrusions occasionally recede telescope-like; others project somewhat in the same fashion.

It is interesting to note that a stone broken in 1873 or 1874 should behave thus. Common enough, perhaps, though not often noticed. I have a memorandum on the labels 19, V. 78. "Numerous flake-like growths formed after the manner of the artificial Lead-tree. Very interesting."

On page 168, No. 100$^{c}$. (Native Copper.) "The vertical accumulation" is now more than one-eighth of an inch increased by the growth of the crystallized form, at its apex. The "column" is now separated at both sides from the longitudinal exudations. The "loop" is fast tending downwards, and has a tendency to collapse and unite with the column. The exudations all along the line have increased in bulk; and some minute copper-crystallizations have appeared on the stone, at some distance from the others. Most interesting.

848 (Argentite.) White Silver-growths very considerably multiplied.

On page 169, No. 18 (Argentite) has on it very many recent curly silver-growths.

846 (Argentite) has a few recent silver-growths.

16$^{c}$ (Argentite.) Silver has grown very much in curls.

More than 25 grains weight of silver has grown off the last three specimens in about 12 months, and the bottom of the tray is covered with dirty silver-dust.

On page 170. No. 2 (Moss-copper in small glass-topped box.) One filament has very much grown in length; other filaments have changed in colors, and one of the largest has become silvery-white! *Mem.* 5, v. 10. White appearance has disappeared. *Mem.* 1, VI, 80

On page 171. 86 and 92. (Quartz.) Electrum-growths are much changed.

100$^{t}$. Interesting electrum-change in a cavity.

100$^{v}$. Electrum enlarged very much.

217. Globule in indexed cavity in process of changing form.

On page 172. 217, 100$^{u}$ (Au., Bi., Te., &c.,) and No. 7 (Electrum) have enlarged considerably.

15ª. The larger gold-growth has perceptibly increased, and anothe has appeared in a cavity. A growth at a corner of the specimen ha considerably increased in bulk, and appears in process of crystallizing Increase noticeable within the last 16 days.

276 and 276ª (Electrum) more generally crystallized.

On page 173, No. 12 (Sponge-gold) changes remarkable.

On page 174, No. 556 and 532 (Quartz-crystals.) Electrum-growt thereon increased.

On page 175, 583. "Mitre-shaped" electrum-growth increased.

501. The interesting electrum-growth is now five-sixteenths of a inch long; being rather more than one-sixteenth longer than when measured it at the beginning of this year. It has also increase sensibly in bulk. The longitudinal groove is deeper. Another groo has appeared all along an opposite edge. This remarkable grow appears separating at its base, and I fear will, some day, *grow off*, other electrum-growths have frequently done. At present, howev it is very firmly fixed in the quartz.

On page 176, No. 832. Large quartz specimen loaned in Jun 1878, to the Liverpool Museum, examined by me Dec. 16, 187 Found that one of the largest electrum-growths, and several small ones had grown off. There appeared, also, several recent growths.

No 834 show electrum-specks recently *grown off*

On page 177, No 594, at index *a*, Electrum palpably developed i length. At *b*, Electrum, apparently, crystallizing into cubic form.

815. The "antler-like" electrum-growth in the gossan-lined cavity has sensibly increased; and, at the edge of the cavity, the electrum has burst through its gossany-coating, and is beautifully bright.

581 has most interesting bright recent electrum-growths in two cavities of the quartz.

525 has electrum considerably increased.

On page 178, No. 511 (quartz.) Electrum has grown and become very interesting. Is probably changing shape to isometric-shape.

566 (quartz) shows recent electrum-growth.

535. Some threads of Moss-gold have fallen off; and others have perceptibly grown. Electrum in cavities, much grown. Here are also, some new growths.

587. Electrum has increased in bulk in several places, and here are three new growths.

520. Copper-looking growth of electrum.

123. Grooves in electrum deeper, and a division likely to take place shortly.

On page 179, No. 196. Electrum increased in length.

No. 10 At index *a*, a gold-crystal forming in cubical system.

At index *b*, electrum has grown off, and in its place have appeared four tiny bright forked branches of electrum.

At index *c* is electrum crystallizing; and also in a cavity behind it are several recent branch electrum-growths.

At *d*, electrum has grown 1-18th of an inch, and has become cork-screw-like in shape.

At *e*. electrum has become much more branched and rather loose. Near it are two recent electrum-growths.

At *f*, electrum crystallizing into cubic form.

Page 180, No. 220 (Brown Blende). Recent electrum-growth at one end of specimen.

215 (Galena, &c.) Electrum-growths, palpably increased. Specimen has become very interesting as to spontaneous movements.

97 and 98. Electrum growths increased in bulk.

502 The scoop-like electrum-growth is now ¼-inch in length; has curved further into the cavity by nearly 1-16th of an inch, has become stouter, and more rugged. The trefoil-like growth in the gossany-cavity has changed its shape by the elongation of its centre-portion.

On page 181, No. 22ª. Electrum-growths increased, and recent ones have appeared in the *undecomposed* marcasite.

207. Electrum-growths palpably increased. The "broad-growth" at the thinnest edge of the specimen in May, 1877, was barely 1-16th of an inch high; it is now more than ⅛th of an inch.

117ª (Mispickel.) The electrum in this specimen has grown fully ⅛th of an inch since I measured it in December last, it thinned out in its process of elongation, and electrum ¼ × 3-16ths inch grew off. Since then, the grown-off portion has curled a little at the edges, and has a tendency to isometric crystallization.

The remainder of the electrum-shape attached to the quartz and unassociated with the auro-pyritous mineral, has sensibly increased in bulk; exhibits a tendency to cubical-crystallization, and is now beautifully bright.

The growth originating in the quartz-cavity has protruded still further, and the cavity appears as if likely to get rid of its tenant at no distant period.

The Mispickel has not in the least decomposed, and no electrum is at present to be seen at its surface.

On page 182, No. 49. The electrum looks more like Native Copper than it did. It would pass for native copper in an ore-heap.

236. The beautiful gold-crystals on this specimen had upon them what appeared to be "parasitic black crystals." Most of them have pushed off their *black coating* and revealed bright faces of octahedral crystals.

The black crystals are now much less numerous. Some are to be seen apart from the principal cluster of gold-crystals. These I have not before noticed; but cannot say positively that they are recent.

The twin-crystals, of which there are, perhaps 200, are very interesting.

20. Some electrum crystallizing into isometric form.

818. The twin electrum-crystal, decidedly increased in bulk, and has become beautifully bright. The other growths have also progressed.

On page 183, 841. Apex of the crystal much brighter.

At index *a*, the electrum-growth in the quartz has increased, and become more pointed. About half-an-inch off it, another growth has appeared. Gold has come to sight in some adjacent blende.

500[f]. Red index *a* points to gold-pseudomorphs in a cavity. Two of these have become brighter at their extremities. In another cavity are some recent dirty-looking electrum-growths; and in a cavity adjacent to this, are some recent bright growths.

On page 229 of the same volume I described some Norwegian (Kongsberg) minerals.

13 Ag. exhibits several recent argentite-growths.

On page 230. 10 Ag. Some new argentite-growths have appeared in a cavity.

11 Ag. shows further development of silver in curly growths.

14 Ag. has elongated a tarnished silver-thread.

On page 231. 6 Ag. shows a bright recent silver-growth out of a slender silver-thread. The growth is out of pistacite.

2 Ag. shows several recent silver-growths.

On page 232. 123 Ag. shows recent silver-growths.

18 Ag. The silver-growth has split open its enclosing calcite, released itself, and both silver and argentite have curled in places!

*Some recent Mineral and Metal-growths not before reported of.*

Specimen 100[d] shows recent Millerite-growth, with electrum-growth at of Mispickel.

699 shows recent electrum-growths at indices *a*, *b*, *c*, *e*, and *f*.

822. Electrum very much increased and recent gold-threads *beautiully bright.*

52. Fifteen electrum-growths sensibly increased, and the specimen aring this progress in a most novel and interesting state.

26 y. Lower Silurian schist containing copper pyrites and black ende, shows numerous electrum-growths and crystallization since 12, i, '77.

771 shows recent electrum-crystallization.

93[a] and 819. Electrum-growths increased.

517. Some interesting electrum-growths.

No. 752. A remarkable change has taken place in the electrum-owths: some of them have become laminated.

58[a] and 564. Electrum-growths much increased, and have become ry bright and beautiful.

401. Electrum-leaf grown off and surface crystallizing into form.

99. Electrum crystallizing isometrically.

837. Electrum shape much changed. Shape indescribable.

679, 115, 41, 153, 21, 117, 93, 566. All exhibit recent electrum-owths.

757, 822, and 101. Electrum-growths increased.

82. Electrum-growths much brighter.

99. Electrum grown off *in gold-dust*!

32[b]. Several bright recent electrum-growths in cavities.

115. Electrum-crystallization in cavities.

205[a]. Electrum cubic-crystallization more perfect.

500[a]. Pyrites decomposing after being boiled in Nitric-acid, dissing long flaky-electrum, some portions of which exhibit recent ght growths. Mem. 6, vii, '80. These growths have all since nished.

500[b]. (In round glass-topped box.) These gold-growths much nged in shape since 16th Dec., 1879. Appear to be changing like before referred to. All these have been detached from matrix.

500[c]. Gossany-quartz (like 535 referred to) calcined in 1874, and l then some of the electrum in *globules*. Found by me in a heap,

June, 1878. Has much changed since. Globules have all changed to undefined shapes.

C. 1. Curved changes in a natural Cape diamond since Dec., 1877.

25. Coil of metallic Cadmium has elongated nearly 1-16th of an inch since January 1st last.

Mem. 6, vii, '80. I have been reading lately Lord Bacon's *Sylva Sylvarum*, published by Dr. Wm. Rawley (1658), and I am tempted to add an extract therefrom in favor of the somewhat objectionable term *growth*.

"Experiment Solitary touching the Growth or Multiplying of Metals."

"It is reported by some of the ancients, that, in Cyprus, there is a kind of iron that, being cut into little pieces and put into the ground and well watered will increase into greater pieces. This is certain, and known of old, that *Lead* will multiply and increase as has been seen in old statuas (*sic.*) of stone, which have been put into cellars; the feet of them having been bound with *leaden-bands*; where (after a time) there appeared, that the *lead* did swell; inasmuch as it hanged upon the *stone* like *warts*." (p. 168.)

## VIII.—*On some Cornish Tin-Stones and Tin-Capels.*

By J. H. Collins, F.G.S.

### Second Paper.

### Wood Tin.

In my former paper (*Min. Mag.*, vol. IV, page 1) the different modes of occurrence of oxide of tin in Cornwall were briefly described, and the characters both macroscopic and microscopic of the ordinary tin-stones and tin-capels were illustrated in considerable detail. I have now to describe the peculiar varieties of "wood-tin" or Cornish tin-ore, which are certainly characteristic of many of the Cornish deposits, although their occurrence is not limited to Cornwall as was at one time supposed.*

The chemical composition of Cornish wood-tin differs very little from that of ordinary Cassiterite, as was shewn long ago by Klaproth. The following analyses were given in my Mineralogy of Cornwall and Devon, pt. 2, p. 24 :—

| | *a.* | *b.* | *c.* | *d.* |
|---|---|---|---|---|
| Oxide of Tin .. .. .. | 93·93 | 96·26 | 91·0 | 94·5 |
| Peroxides of Iron and Manganese | 0·32 | 3·40 | 9·0 | 1·5 |
| Silica .. .. .. .. .. | 0·75 | 0·75 | — | 1·0 |
| Alumina .. .. .. .. | — | — | — | 3·0 |
| | 100·00 | 100·41 | 100·0 | 100·0 |

*a* was a specimen from Altarnun, analysed by Klaproth, *b* was analysed by Thomson, *c* by Vauquelin (sp. gr. 6.45), and *d* by Johns.

The following percentages of metallic tin were obtained by means of a charcoal crucible and blast furnace, by Klaproth :—

| | |
|---|---|
| Light-brown acicular crystals .. | 75 per cent. |
| Grey crystals from St. Agnes .. | 74 ,, |
| Wood Tin .. .. .. .. .. | 73 ,, |
| Stream Tin from Ladock .. .. | 76 ,, |
| Stream Tin, Altarnun .. .. | 76 ,, |

* Among foreign localities for wood-tin the detrital deposits of the Mexican uplands may be especially referred to. In these many nodular and concretionary masses of a yellowish or reddish-brown wood-tin occur—sometimes associated with the rare mineral mangrite. These, however, unlike most of the Cornish wood-tins, generally contain a very large proportion of oxide of iron.

The tin so obtained, however, would contain traces of the iron, manganese, and other metals contained in the ore. On the other hand there would be a certain loss of metal in the slag which would more than compensate for the increase from this source in such pure selected ores, so that the results obtained were on the whole remarkably near the theoretically possible quantity of 78·67 p.c. of metallic tin.

The following are analyses made by myself:—

| | *a.* | *b.* | *c.* |
|---|---|---|---|
| Tin .. .. .. .. | 77·80 | 72·50 | 74·6 |
| Iron .. .. .. .. | ·21 | 5·22 | 2·3 |
| Manganese .. .. .. | traces | traces | 1·2 |
| Silica .. .. .. .. | traces | ·31 | ·2 |
| Oxygen (calculated) .. | 21·20 | 21·86 | 21·7 |
| Loss .. .. .. .. | ·79 | ·11 | — |
| | 100·00 | 100·00 | 100·0 |

The general appearance of wood-tin has been already described*—the more important varieties are illustrated in the plates VII to XI, which accompany this paper.

The Garth Mine has already been referred to as a notable locality for wood-tin. Balleswidden Mine in St. Just has also been given as a locality.

The following extracts from Mr. Carne's account of the Garth mine (*Trans. Roy. Geol. Soc. Cornwall*, IV, p. 99) will be found of considerable interest. The paper was read in October, 1830. "The Garth Mine, known also as East Wheal Cock, is situated on the side of a granite hill, about two miles from Penzance, on the Land's-end road. Eastward the lode is in granite, westward in killas, but the workings have all been in the granite portion." After adverting to the former history of the mine, Mr. Carne continues—"About three years ago the Garth was again set at work, with an engine worked by a water-wheel for draining the water: the present workmen, on exploring the lode immediately below the *old workings*, found it productive of tin, and it has continued so to the present depth of thirty fathoms, although scarcely rich enough to pay the expenses which attend the concern: the tin-ground in the lode is about six fathoms in length, and occurs directly westward of the intersection of the lode by a clay cross-course on which the adit was driven; the lode has not been explored east of the cross-course.....In all this space, wood-tin and

* *Min. Mag.*, vol. IV, p. 6.

Some beautiful coloured figures of wood-tin are given in plate 1, of the Catalogue of the Rashleigh collection, published in 1797. A good drawing of the "needle-tin" from Glasteining mine in St. Mewan (now I believe known as St. Austell Consols) is given in pl. 4. Some of these "needles" are extremely fine, but unlike the "fibres" of wood-tin which are nearly opaque, these are very transparent.

† *Rep. Roy. Inst. Corn.*, 1841, *p.* 38

ads'-eye tin have been plentifully found; tin in globular distinct con-retions, from the size of a pin's head to that of a pea has occurred more paringly; and of botryoidal-tin only a few specimens have been met ith....Of the specimens which I have the pleasure to present to the ociety,* Nos. 1-6, are of the lode itself: it has in general a very granitic ppearance, but it is not granite, its constituent parts (except the metallic es) appear to be quartz, felspar, and chlorite, coarsely mingled together; e two former highly crystalline. The only metallic ores which I have served in it are the carbonate of iron and the oxide of tin; the tin is t generally scattered throughout the stone, but exists in singular forms, d in such modes as have been seldom if ever observed before. Where e felspar predominates the tin occurs in small separate layers between e crystalline masses of felspar, possessing the fibrous texture and brown lour peculiar to the wood-tin as in specimens 7-8. It occurs also in ntemporaneous veins in the quartz as in No. 9, and in similar veins tween the quartz and another constitutent part of the stone as in No. ,and investing the sides and summits of the quartz crystals as in Nos.11, . No. 13 is a specimen of the globular distinct concretions; on breaking stone these concretions are often found bedded in one part and capped the other as in No. 14, when broken they commonly present the ap-arance of toad's-eye tin as in Nos. 15-16. In some of the specimens o or more of these varieties may be observed in the same stone, as in s. 17-18. No. 19 presents the wood-tin with a rough botryoidal rface." Several of the varieties referred to by Mr. Carne are described d figured in Plates VII and IX. The figures are however drawn from ecimens in the Truro Museum.

*Wood-tin, Garth Mine* (Plate VII, fig. 1.) This specimen is in the uro Museum. It consists essentially of a layer of dark brown wood-tin nly coating the sides and summits of the large quartz crystals at *c*. is is succeeded by a series of bands of hair-brown wood-tin, grayish rtz, and pale pink felspar several times repeated. At *e* is a band of en chloritic substance which probably formed the wall of the lode from ich the specimen was derived. What was the entire breadth of the e in this part we have no means of knowing as the other side of the cimen is broken away.

*Wood-tin Garth Mine.* (Plate VII, fig. 2.) This very peculiar re is also drawn from a specimen in the Truro Museum. It sists mainly of crystals of pink felspar which are just in contact with h other—so as to leave numerous angular interspaces. These are all

* The Royal Geological Society of Cornwall. The specimens are preserved in the seum at Penzance in wall-case No. 11.

filled with very compact dark-brown wood-tin, as indicated in the figure. There is scarcely any quartz in this stone.

*Wood-tin, Garth Mine.* (Plate IX.) This is another figure drawn from a specimen in the Truro Museum. It consists of fine alternating layers of quartz, pink-felspar, and wood-tin, part of a thick band from granite "country." This is an exceedingly beautiful specimen, but not so rich in tin as the last described.

*Wood-tin, Tregoss Moor.* (Plate VIII.) This magnificent specimen was found in the slightly water-worn detrital deposits of Tregoss Moor, and is now in the Truro Museum. It has evidently at one time formed part of the filling of a fissure, but the original locality is not known. At *b* the stone consists of a peculiar pale brownish-gray quartz, a *melange* apparently of small irregularly formed crystals. At *c.c.* is a band of moderately large prisms and pyramids of quartz, pointing no doubt as is usual towards the interior of the fissure. Upon and between these crystals is a series of layers of wood-tin, varying in tint from very pale hair-brown to a very dark chocolate tint, many of the layers being less than one-hundreth of an inch in thickness. Then upon this we have the main mass of confusedly crystalline quartz enclosing small patches of wood-tin, and, at the farthest edge a semicircular mass which is no doubt part of a band corresponding to that first mentioned. All the wood-tin here is most perfectly concentric, and also radiated in structure.

How wide the original fissure was cannot be determined, as not the slightest appearance of a wall or selvage is to be seen; but it must have been considerable in the part from which this specimen was derived, even though there had been only these two layers facing each other, i.e. that there was no re-opening and re-filling of the fissure. Its total breadth could not have been less than .6 inches, and may have been as much as 9 or 10 inches. Such a lode would be capable of yielding in each fathom of length and depth nearly two tons of tin-ore. Of course there may have been several such layers in the same fissure, forming a gigantic specimen of "banded" or "combed" structure.

*Shot-tin* (Pl. X., figs. 1 and 2). This very remarkable form of wood-tin was first noticed by Klaproth—and it is the rarest of all the forms. Its general appearance is very remarkable, that of a number of small brown shot, varying in size from a pin's head to the 16th of an inch, embedded in and cemented together with a greyish-brown cement. In fig. 1 a section is drawn as seen with the $\frac{1}{2}$-in. objective ($\times\frac{66}{1}$). The greyish circles are sections of spheres, generally more or less broken or incomplete—sometimes hollow, sometimes containing a kernel of nearly opaque wood-tin. The spheres themselves do not appear to be composed

cassiterite, but I am not at present able to say of what material they consist, as I have but a very small fragment of the stone at my disposal. They are surrounded on all sides by distinctly radiated wood-tin, as shewn in the sketch. The matrix encloses a number of prisms which appear to be quartz; similar crystals are embedded in some of the spheres. In fig 2 the same section is shewn as seen with the 2-in. power ($\times\frac{16}{1}$). The specimen from which the sketches are drawn is said to be "from near Penzance," but the exact locality is not known. It is, however, probably from the Garth Mine.

*Carvear, St. Austell.*—In this specimen the wood-tin occurs in little botryoidal layers and groups of spherules enclosed in nearly white quartz. As in every other case, the spherules exhibit the radiated and concentric structure.

*Wood-tin, Prideaux Wood Mine* (Plate XI, fig. 1.) This is an illustration of the very remarkable brecciated stanniferous deposit already referred to.* Referring to one of the finest masses discovered, my friend Capt. John Simmonds, of Liskeard, writes me as follows:—"The wood-tin found at Prideaux Wood was discovered in a lode of copper-ore; it was a large kidney-shaped specimen, but, unfortunately the men broke it up to see what it contained, supposing it to be iron. No one knew what it was until I brought it up from underground, and had it bruised down and calcined, when it shewed a splendid "vau" of tin. I have a part of the stone (also some small fragments) which in appearance closely resembles a specimen of wood-iron alongside of it." Some fragments of the included radiated masses (for which I am indebted to my friend Dr. C. Le Neve Foster) are drawn as seen under the microscope in Plate XII.† The appearance to the unaided eye is beautifully represented in the Rashleigh catalogue already referred to. The concentric bands are alternately light and dark-brown, some few being very nearly black.

*Wood Tin, Roche*—Specimens of wood-tin associated with tourmaline-schist and quartz were presented to the Truro Museum many years since by Mr. W. Mansell Tweedy. One of the specimens, besides the usual narrow bands and botryoidal or mammillary crusts, has a fine circular radiated mass of wood-tin about one inch in diameter. Mr. Tweedy remarks of the wood-tin from this locality, "The specimens were of unusual beauty, one which I obtained for Mr. Williams had the radii at least an inch in length. The specimen I have the pleasure to exhibit will illustrate the character of the larger specimens: it is of a light hair-brown colour internally, darker externally, sprinkled with minute crystals of white quartz, in nodular concretions in a dark, nearly black and

* First Paper, p. 7.

† On analysis this wood-tin yielded 25 p.c. only of peroxide of iron.

schorlaceous rock. In other specimens the wood-tin in radiating fibro masses with darker concentric bands, is intermixed with the schorl rock Some of the specimens exhibit a brecciated structure; the tin mix with schorl apparently serving partly as a cement. Some of the woo tin masses are coated with minute nearly black crystals of cassiterite.*

*Wood-tin, Gavrigan Mine*—A specimen in the Truro Museum marked above, consists of dark-brown irregular masses of wood-tin, coated wi brilliant black crystals of cassiterite, resting upon and occupying fissures tourmaline schist. It does not essentially differ from the specimens abo described as from Roche, and may probably be from the same locality.

*Wood-tin, St. Agnes*—A specimen exhibited at the annual meeting the Royal Institution of Cornwall in 1841, was thus described b Mr. W. M. Tweedy, "The specimen from St. Agnes is a fragme showing a portion of the lode and both walls, with some of the *coun* on each side, which is a very hard siliceous killas. The fibrous wo tin is principally at the sides of the lode, which assumes in the centr more uniform structure, and incloses fluor spar, quartz, and some mundic

*Toad's-eye tin, Polberrow Consols*—This occurs in minute light dark brown spherules and mammillary coatings. Many of the spheru are not more than one-sixteenth of an inch diameter, and very few more than one-tenth of an inch. However minute the spherules, th all exhibit the characteristic concentric and radiated structure. Some the spots have a dark centre, surrounded with a lighter band, a da margin beyond presenting a very considerable resemblance to a toad's-ey Unlike the toad's-eye tin (described on p. 14 of my former paper) fro Penhalls, these from Polberrow contain no crystals of cassiterite in th interior and no quartz.

*Wood-tin, Penhalls Mine.* For this very beautiful specimen I a indebted to Dr. Foster. It is of a general dark gray colour, banded wi narrow curved lines of white quartz, alternating with others of grayish an brownish wood-tin. The whole has been at some time broken across and r cemented with white crystalline quartz. The separate layers of tin oxi and quartz in this specimen are almost inconceivably fine, dozens may b counted in the space of an eighth of an inch in some places (Plate X fig. 4.)

This mine is situated on the edge of the cliff on the east side of Tr vaunance Cove. Its singular "heaves" were described by the late M John Pike‡ and some of the more remarkable features of the miner deposits were detailed by my friend Dr. C. Le Neve Foster.§

* *Rep. Roy. Inst. Corn.* 1841, p. 38.
† *Rep. Roy. Inst. Corn.*, 1841, *p.* 38.
‡ *Quart. Jour. Geol. Soc.*, XXII, p. 535.
§ *Trans. Roy. Geol. Soc. Corn.*. IX, pp. 206-9.

Capt. S. Bennetts, the manager of the mine, describes the occurrence of he wood-tin here and at the neighbouring mine of Blue Hills in the ollowing terms:—"The wood-tin obtained in those mines has principally een found near the various intersections of the tin-lode by the so-called gossans" (parallel veins having opposite underlie and faulting the tin-odes.) It is found too in greater quantities near those faults on the borders of ood deposits of cassiterite. On one occasion in the western part of the ine, under these conditions large lumps several pounds weight were ound of solid massive wood-tin. It is often found in small rounded con-retions, occasionally covered with a coating of a friable oxide of tin, just exactly like putty powder, both in colour and appearance) as ne as the finest slime, and as easily washed off; and again this in some ases is hard as flint, of a pale-straw colour and without any granular tructure so far as I can magnify it. I have generally considered this to e a *silicate* of tin. As to the *quantity* of the wood-tin found in this and he Blue Hills Mines from time to time, it is difficult to estimate; but om its being so often met with, and sometimes by no means small in uantity; I should think some tons of it had been met with since I ave been connected with the mines."*

*Capel, Brookwood* (Pl. X., figs 3 and 4). This is a dark granitic capel hich was not known to contain tin till it was examined in thin sections nder the microscope. It consists of a series of dark-brown and nearly paque patches, which appear to be composed of oxide of iron and amor-hous tourmaline, occupying cavities in what was originally a vesicular ock. Around these, as seen in section, we have a narrow band of quartz rystals with their principal axes radiating from the dark centre. The mmits of these are coated with an extremely thin layer (sometimes vo or three distinct layers) of wood-tin. The interspaces are filled up ith hyaline quartz. The quantity of metallic tin contained in the speci-en here illustrated did not exceed 4 lbs. per ton, or less than ¼ per cent. ig. 3 shews the section as seen under the 2-in. power ($\times\frac{16}{1}$), fig. 4 with in. power ($\times\frac{66}{1}$).

*Blue Hills, St. Agnes*, (Pl. X., fig. 5). This is very similar to the ecimen from Brookwood, but the layers of wood-tin are somewhat icker, and the quartz crystals radiating from the dark patches are also parated from each other more or less completely by layers of wood-tin, other words the faces of the prisms as well as those of the pyramids e coated with wood-tin.

*Wood-Tin, Wheal Vor* (Pl. XII, fig. 1.) The stone here illustrated is om a deposit which occurred near that described by Mr. G. M. Henty, d already referred to in my former paper.†

* Private communication, August 12th, 1880.

† First paper p. 7.

The mode of occurrence of this deposit is thus described by my frie Mr. Argall in the Journal of the Royal Institution of Cornwall.* "T ancient and well known mine of *Wheal Vor*, situate on an elevated pla of chloritic slate immediately East of Tregoning Hill, an isolated body granite, has, perhaps, afforded more tin ore than any other land of equ extent in Cornwall.

The *Wheal Metal Lode* bears 10°-15° N. of E—S. of W., and li most of the other *lodes* in *Wheal Vor*—dips some 65°-80° N.

Some six or seven years since, traces of *wood-tin* were discovered abo 180 fathoms from the surface, west of the *Metal* shaft; and, within a f months, ore of much the same character has been found at some 200 fathom deep, 80 fathoms further east in the same *lode*, which maintains for so considerable extent an average width of about two feet. Almost sudden however it attains a breadth of about six feet, and the vein-stone, at t same time, becomes less quartzose, more chloritic, and contains a lar proportion of crystalline tin of the ordinary character. These are so times separately aggregated, though frequently they are more or mixed; but whether the ingredients are earthy or metallic, the *wood-* occurs either in scattered grains, in small isolated masses, or in veins unequal yet always of inconsiderable width; and these--even when thicker than paper, display the most capricious and complicated flexur and still preserve a fibrous structure. Both in the broader parts of the narrow veins, and in the small bodies of ore, whether imbedded ordinary cassiterite, or in earthy ingredients, radiated crystalline, as wo as a concentric lamellar structure prevails, the successive rings or cylinder of ore being alternately of clove-brown and of brownish-yellow hu These aggregations of divergent crystals sometimes enclose kernels ordinary tin-ore; but now and then they radiate from minute cavitie *(vughs)*, which, in such cases are lined with microscopic pyramids cassiterite.

As wood-tin has been so rarely found in *lodes*, and in no instance ye recorded from so great a depth as in *Wheal Vor*, I venture to hope th the foregoing description of the conditions under which it occurred ma not be uninteresting."

It is very dark-brown, has a sp. gr. of 6·32, and contains 1·95 p.c. oxide of iron. Under the microscope with the 2-in. power, it has the appea ance represented in fig. 1, pl. XII, the fibres or needles of cassiterite bein intermixed with a little quartz, so as to exhibit the most brilliant colou with crossed prisms. A little colour, no doubt due to interference, visible without using polarized light at all. The mineral is only translucen

* Vol. IV. p. 255, 1873.

even in very thin sections. The thin vein and branch shewn represent what looks like an alteration of the brown fibrous wood-tin to ordinary translucent crystallized tin along a narrow fissure. In parts only of these fissures do we see any quartz in particles of distinct size, but minute granules appear to be present throughout the mass.

All the specimens of wood-tin which have come under my notice, including those above described and figured, agree in being nearly opaque, even the light-coloured varieties being much more so than the blackest crystals of tin-oxide. A fibrous-concentric structure is always visible, and, owing to the little adhesion existing between the separate layers and fibres, the mineral is very brittle when cut into thin slices, although it may be tough in mass. The sp. gr. is usually about 6·1 to 6·45, or somewhat lower than in crystallized cassiterite, and it is much more readily acted on by a mixture of sulphuric and hydrochloric acids, as first noticed by Klaproth. Some remarks on its probable mode of origin will be made in a future paper.

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*Wood-tin of comparatively recent formation.*—In the year 1871, an anciently smelted ingot of tin from Tremethack Moor in the parish of Madron, was purchased for the Royal Institution of Cornwall. This block was partially covered with a hard and brittle coating, in some places as much as ¼ in. thick. The brown colour was not evenly distributed, some parts being darker than others, and under the microscope a few shining particles of metallic tin were visible. The specific gravity of the crust was 5·64. I found its composition to be as follows:—

| | |
|---|---|
| Moisture evolved at 120° C. .. .. .. | 6·25 p.c. |
| Metallic Tin .. .. .. .. .. .. | ·43 |
| Chloride of Tin .. .. .. .. .. .. | 1·66 |
| Peroxide of Tin . .. .. .. .. .. | 90·62 |
| Peroxide of Iron.. .. .. .. .. .. | 1·04 |
| Silica .. .. .. .. .. .. .. .. | ·41 |
| | 100·41 |

In describing this crust to the Royal Institution, I said "The crust therefore appears to be composed chiefly of peroxide of tin, somewhat resembling that native variety of Cassiterite called "wood-tin," but neither so hard nor so heavy. It has no doubt been formed by the slow oxidation of the outer surface of the block of metallic tin The slowness of the change is, perhaps, indicated by the dense condition of the incrustation.* A similar sample was submitted about the same time to Mr

* *Journ. Roy. Inst. Corn.*, XIII, 84, 1871.

Jas. Napier, F.C.S., who wrote of it as follows: "The incrustation which invests the mass of *Jews'-house tin* from Tremethack Moor is a pure peroxide of tin, with a mere trace of iron; in short, the metal has been reconverted into *tin-stone*. This is of exceeding interest, as it shews how pure the metal must have been."*

Similar tin-crusts have since then been placed in my hands from several different localities.

In comparing the crust to wood-tin, I had in view the hardness, specific gravity, and brown colour of the specimen. I have lately, however, cut some microscopic sections from the fragments of the crust still in my possession, and I find the characteristic radiated-concentric structure with a tendency to assume botryoidal forms, in fact the most precise agreement in the appearances presented under the microscope to those presented by ordinary wood-tin.

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## Pseudomorphous Tin.

Reference has already been made to certain pseudomorphous occurrences of cassiterite in Cornwall.† The most important of these may be here described as follows:—

### *a. Oxide of tin, pseudo. after felspar.*

This is the best known of the Cornish pseudomorphs. Its occurrence in considerable abundance at Wheal Coates in the parish of St. Agnes in the year 1828, was thus described by Mr. Stephen Davey.‡ "Huel Coates is an ancient tin-mine, situated about three hundred fathoms north-west of St. Agnes Beacon. The adit level is about fifty-five fathoms below the surface, and five fathoms above high-water mark. The mine has never been worked more than a few feet below this level.

The crystals in question were discovered in a small vein (composed principally of light-red sand) whose usual width is not more than three inches; but just at this spot it becomes enlarged to twelve inches: they were first discovered about three fathoms above the adit, and continued in the vein to the height of six fathoms, and for two or three fathoms in length; here the small vein was intersected by a large one, about three feet wide (composed of ore-stone and sand, underlying northward about three feet in a fathom) which *heaved* it; and as the mine has not since been much explored, the vein containing the tin crystals has not been discovered on the other side of the larger vein.

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* Ibid.

† First Paper, p. 8.

‡ *Trans. Roy. Geol. Soc. of Corn.*, IV, p. 484. See also Dr. Boase, p. 291, and Mr. Hawkins, p. 140.

"The crystals have generally the usual form of felspar crystals; the most common is that of a flattened rhomboid with the angles deeply replaced; they frequently cross and overlap each other. The quantity of oxide of tin contained in them varies greatly, some containing only ten and others as much as seventy-five per cent. Many appear as if they had been broken, and the pieces afterwards cemented together by minute crystals of tin. The crystals first found were small and imperfect; but they increased in size, and became better defined as they approached the centre of the bunch; but from this point a gradual decline took place until they nearly corresponded with those first discovered."

"The veins or lodes in Huel Coates are in soft or decomposed granite or elvan. In this substance similar crystals of a kind of sandstone have been found containing no tin; these occurred on the north of the small vein for the space of two feet in width and fifty fathoms in length."

Referring to some of these crystals Mr. Tweedy says*: "The specimens on the table will exhibit the process of change in various stages, but I would particularly direct your attention to some in which the infused portion of tin-stone has not sufficed to fill the cavity left by the felspar, in which case crystallization has taken place, and the tin-stone has assumed its ordinary form."

The crystals are really twins of the Carlsbad type—some very simple, others highly complex, of four, eight, or even twelve individuals. Some of the more elaborate forms are figured in Groth's *Zeitschrift*† When viewed in thin sections under the microscope the tin is seen in dark-brown opaque masses, usually more thickly aggregated around the borders of the section than elsewhere, but in some occupying the whole of the section, except that there are usually some cavities visible—both angular and irregular. In these, occasionally, distinct though minute crystals of cassiterite are observable.

With the $\frac{1}{4}$-inch power ($\times \frac{150}{1}$) most of the tin still remains opaque and formless but a few crystalline grains are usually visible. The crystals containing only a little tin are seen to be very unlike ordinary felspar (orthoclase). They consist of irregularly aggregated bundles of minute fibres, just like the substance of the elvan from Trelaver Downs‡ described and figured by me a few years since. The tin begins to shew itself on the edges of the sections as a brown opaque cloud entangled among the fibres, and from this small beginning it can be traced up to crystals in which very little beside tin is visible.

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* *Rep. Roy. Inst. Corn.*, 1841, p. 39.

† *Zeit. f. Kryst. u. Min.* 1, plates VII and XVII.

‡ See "On the Trelissick elvan and on a proposed classification of the Cornish Elvans."—*Trans. Roy. Geol. Soc. Corn.*, IX, p. 221.

In a few cases nearly the whole of the tin replacing the felspar is in a crystalline condition, and then the resulting mass precisely resembles the patches of tin filling cavities after felspar in the Terras elvan already referred to.

The following additional particulars relating to this peculiar mode of occurrence of tin-ore were communicated to the Royal Institution of Cornwall by Mr. Tweedy in the year 1845 :—"The direction of the great lode is nearly east and west. In it scarcely any tin is found, but it carries a good deal of iron and some manganese. The lode in which the pseudomorphous crystals have been found carries its head about 16° south of east, and from its containing a large quantity of sand is called the sand-lode. In fact for a distance of about 25 or 30 fathoms on each side of the point at which it intersects (is intersected by, see Mr. Davey's detailed account *supra*) the great lode, it is filled with a light-coloured sand, containing a large proportion of tin disseminated through it. This sand is commonly aggregated into large nodules or balls, in which the tin crystals are found.....The sand lode also contained numerous fine strings of rich tin-ore running through the sand. The lode had its regular walls, and was at the intersection and for some distance on each side about three feet big, which gradually decreased to about 5 or 6 inches, and as the lode became smaller, instead of sand it was composed of schorl rock with a felspathic base of a light colour containing a good deal of talc (Gilbertite) and a considerable proportion of tin; as the distance from the great lode increased the sandy character of the schorl rock changed, it became more compact and contained less tin."

"The tin-crystals....occurred principally between 55 and 75 fathoms from surface....In the sand lode and in a parallel lode to the north of it masses of botryoidal and stalactitic siliceous black iron-ore containing a very large proportion of manganese with some tin also occurred....in the cavities of these masses, pseudo-crystals of tin occur, which appear as if they had been entangled in the mass of silex and iron....The most remarkable crystals are two in my own collection—one of sandstone, the other of tin, which have been traversed by a vein of iron which has shifted the parts of the crystal on each side of it, in the case of the tin crystal as much as 3-20ths of an inch—the heave appears to have been an oblique one. I have also several of sandstone traversed by minute veins of iron apparently filling up fractures in the crystals."*

The more recent workings at Wheal Coates, on Towanrath lode, have been described by Dr. C. le Neve Foster,† and he states that most of

* *Rep. Roy. Inst. Corn.*, 1845, p. 20.

† *Trans. Roy. Geol. Soc. Corn.* IX p. 211.

ıe tin "is derived from the killas on the hanging-wall side. The ıclosing rock or *country* is here full of little veins of white clay (*prians*) ıd cassiterite. Many of the little strings are not thicker than a knife-lge, others ⅛-in. or even 1-in. wide . . . . . the killas is traversed in l sorts of ways by these tinny branches, which extend from two to four thoms south of the lode. The killas, on the foot-wall side is either estitute of tinny veins or contains very few."

Pseudomorphs of tin after felspar, precisely similar to those from Wheal oates have been also observed at Carn Brecon* and at Balleswidden ıine, near St. Just. †

Felspar cavities filled or partially filled with crystallized cassiterite, or ith a mixture of cassiterite and schorl are common in the Terras Elvan ready referred to, (see Plate XI) in the felspathic elvans at Belowda ill (Plate III. fig. 3) and Castle-an-dinas; and in the schorl-rock of ock-Hill, near St. Austell;‡ as well as in many other parts of Cornwall.

### *b. Oxide of tin pseudo. after Quartz?*

The so-called "Silicate of tin" from Wheal Primrose has been thought to pseudomorphous after quartz, but the microscope shows it to be of quite different nature. The crystals are of a grey colour—generally they are oups of rough hexagonal prisms with broken or irregular terminations shewn in Plate XI. In thin sections the quartz is seen to be led with minute botryoidal groupings of tin particles, nearly or quite aque and of a brownish colour. They are in fact enclosed in the quartz, st as we often see chlorite, oxide of iron and other minerals enclosed quartz. I have only been able to get one specimen of the supposed ıartz pseudomorph, but I have little doubt that they are all the same, d that there is no such thing as a pseudomorph of tin oxide after ıartz—except of course the well-known natural moulds already referred as being formed by the deposit of a layer of tin oxide on a quartz ystal. It is indeed probable that any solution which could dissolve and rry away quartz would also carry away cassiterite.

### *c. Oxide of tin pseudo. after organic forms.*

In the British Museum, and in the Museum of the Royal Geological ciety of Cornwall, at Penzance, are several fragments of deer's horn ntaining oxide of tin. A great many of these are said to have been ınd formerly in the tin stream-works in the Carnon and Pentewan

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* T. M. Hall; *Mineralogists' Directory*, p. 131.

† R. Pearce, *Rep. Roy. Inst. Corn.* 1861, and 1863.

‡ "On the occurrence of Achroite at Rock Hill." Min. Mag. 1. p. 55.

Valleys, and to have been sold to the smelters. The specimens in th British Museum appear to contain a large quantity of tin, but I have no been able as yet to learn what is their specific gravity. In some part the original horn structure seems to be almost entirely reproduced preserved in oxide of tin. The specimen belonging to the Penzance Museum has been very kindly placed in my hands by the council fo examination, both chemical and microscopical. It is represented on plat XI drawn one half its natural size.

The specific gravity of the whole fragment, and also of a small piec cut from it is 2·7.* Its analysis is as follows:

| | |
|---|---|
| Calcium Phosphate .. .. .. .. | 80·04 |
| ,, Carbonate .. .. .. .. | 2·24 |
| ,, Fluoride .. .. .. .. | ·50 |
| Ferrous Disulphide .. .. .. .. | 1·66 |
| Ferric Oxide .. .. .. .. | ·62 |
| Stannic Oxide .. .. .. .. | 2·60 |
| Silica .. .. .. .. .. .. | ·22 |
| Organic matter and loss.. .. .. .. | 12·12 |
| | 100·00 |

It will be seen that in this specimen the amount of tin is somewh small. It is still however an important constituent of the mass.

The microscopic appearance of the horn as seen in thin sections represented in plate XII.† The oxides of tin and iron, and the iron pyrite have found their way to the interior of the bone and are visibl throughout the structure, although somewhat more abundant near t periphery than in the interior.

### *d. Oxide of tin pseudo. after Wood.*

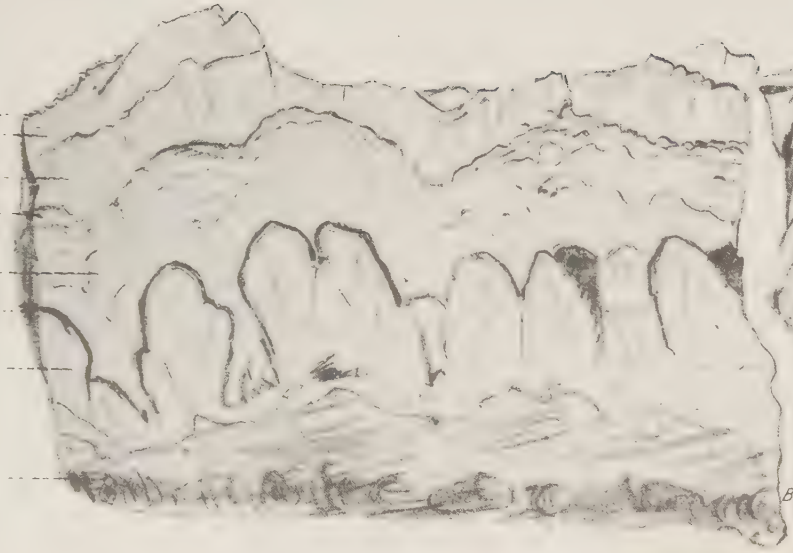
Pieces of wood impregnated with oxide of tin are said by many tin streamers to have been found in the tin-gravels. No such specimens hav come under my notice, but I see no reason to doubt their occurrence. should much like to examine such a stanniferous wood, and perhaps th mention of my desire here may lead to its gratification.

* The sp. gr. of unaltered (recent) deer's horn (fallow deer) I find to be 1·26, and organic matter 62 p.c.

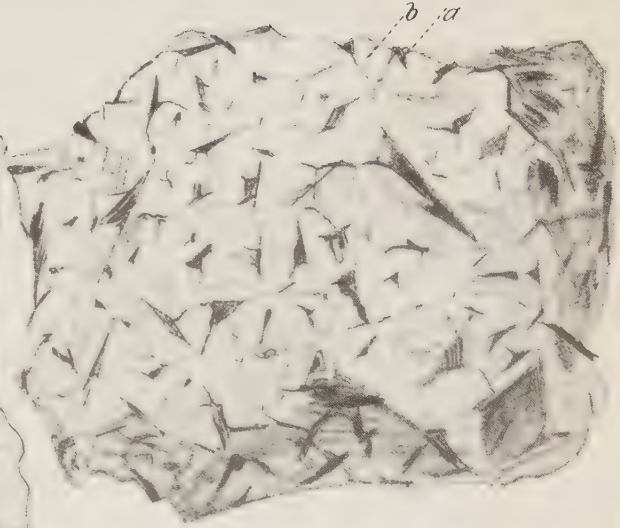
† This plate will appear in the next number of the Mineralogical Magazine.

# CORNISH TIN STONES.

a = WOOD TIN.
b = ALMOST AMORPHOUS QUARTZ.
c = LARGE CRYSTALS OF QUARTZ.
d = PALE PINK FELSPAR.
e = CHLORITE.




WOOD TIN IN QUARTZ.

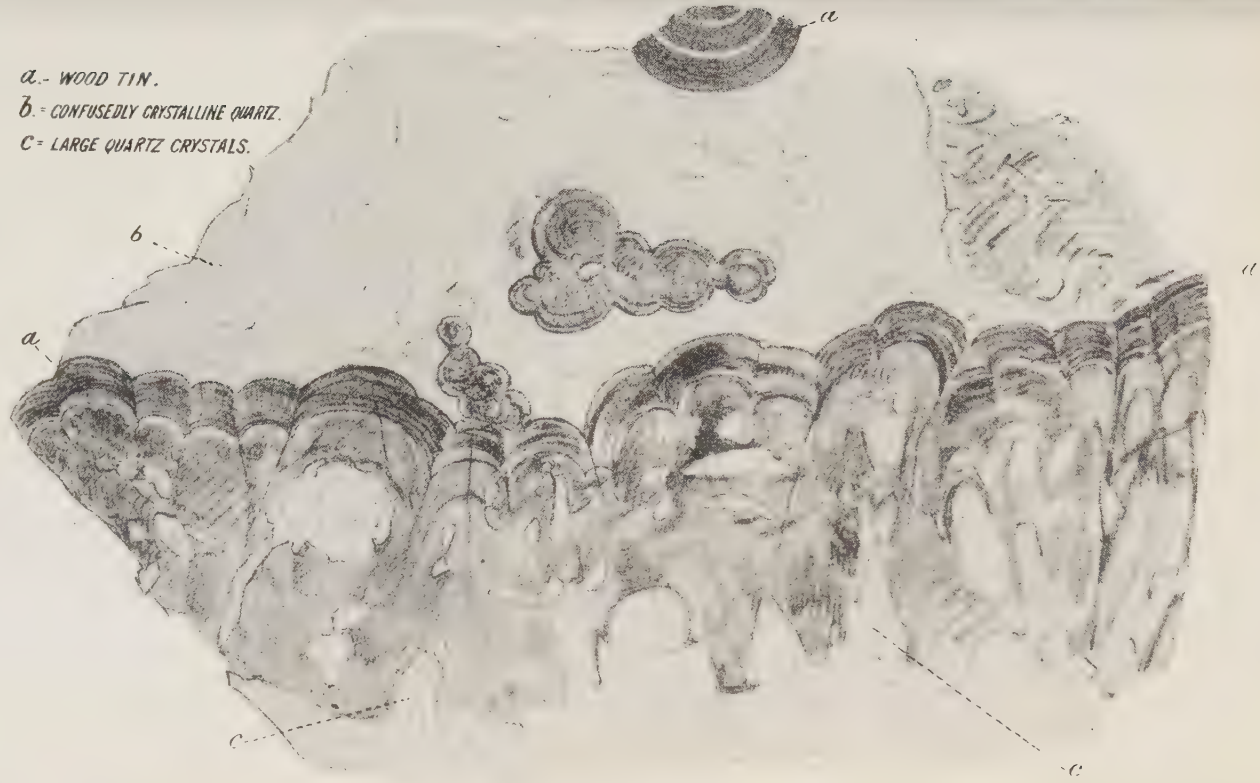



BROWN WOOD TIN IN PINK FELSPAR. NAT. SIZE.

a = WOOD TIN.
b = FELSPAR.

J.H.C. Del.

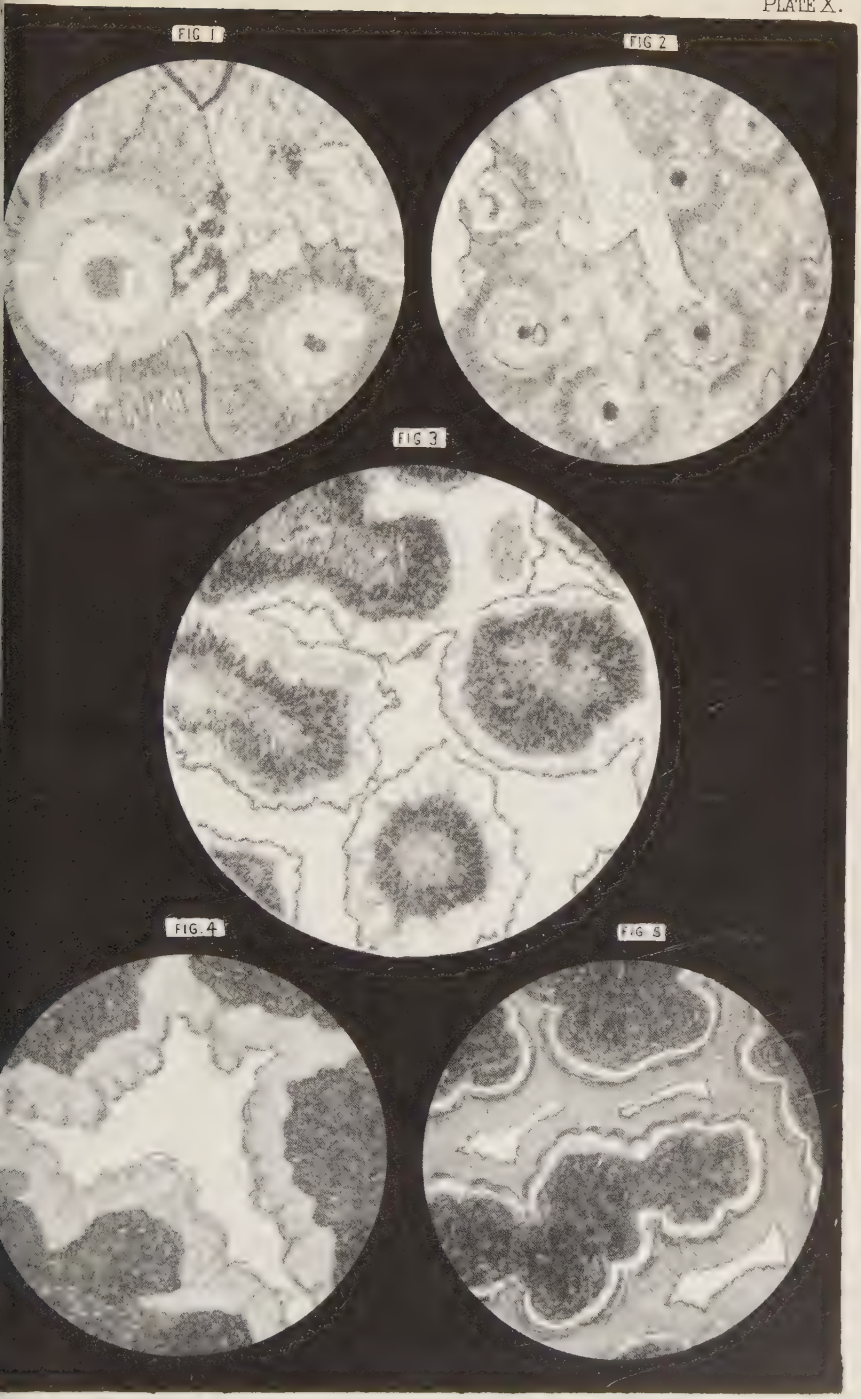
CORNISH TIN STONES.



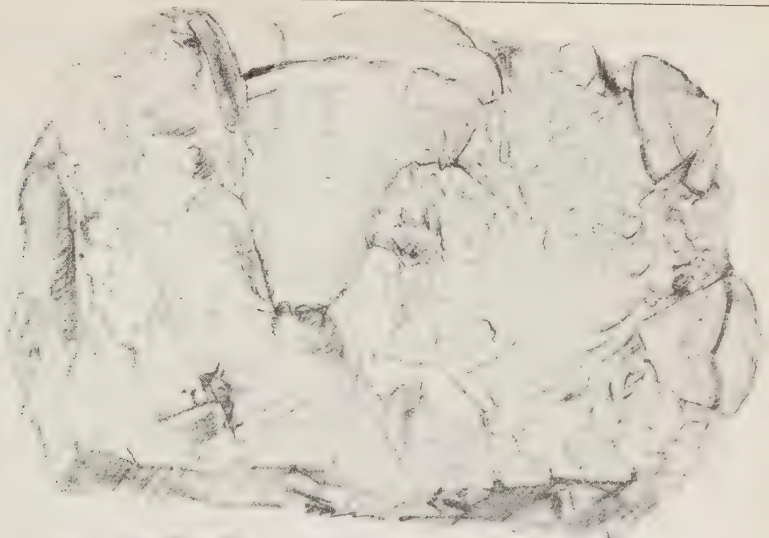
# CORNISH TIN STONES.

WOOD TIN IN FELSPAR & QUARTZ.

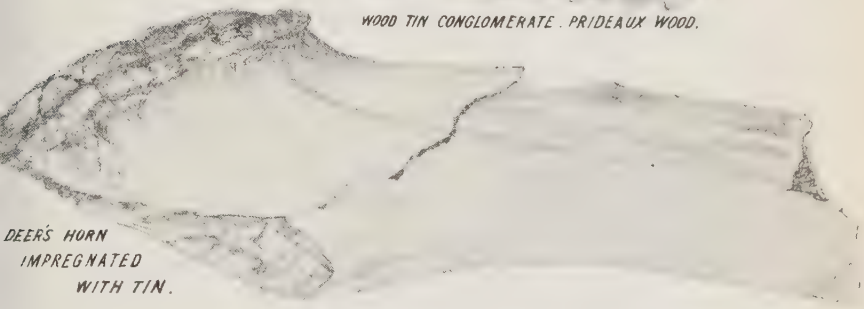
J H.C. DEL.




COPIED FROM ORIGINAL COLOUR PLATE

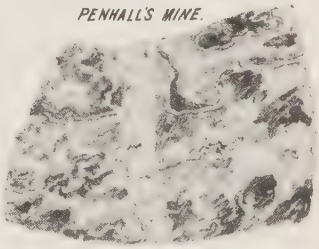


WOOD TIN CONGLOMERATE. PRIDEAUX WOOD.

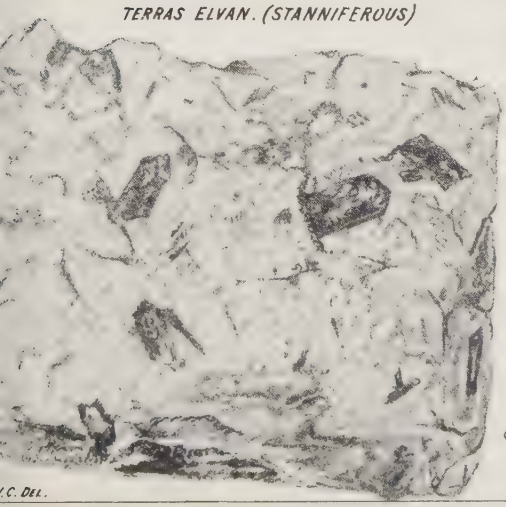


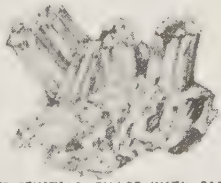
DEER'S HORN IMPREGNATED WITH TIN.

WOOD TIN. PENHALL'S MINE.



TERRAS ELVAN. (STANNIFEROUS)

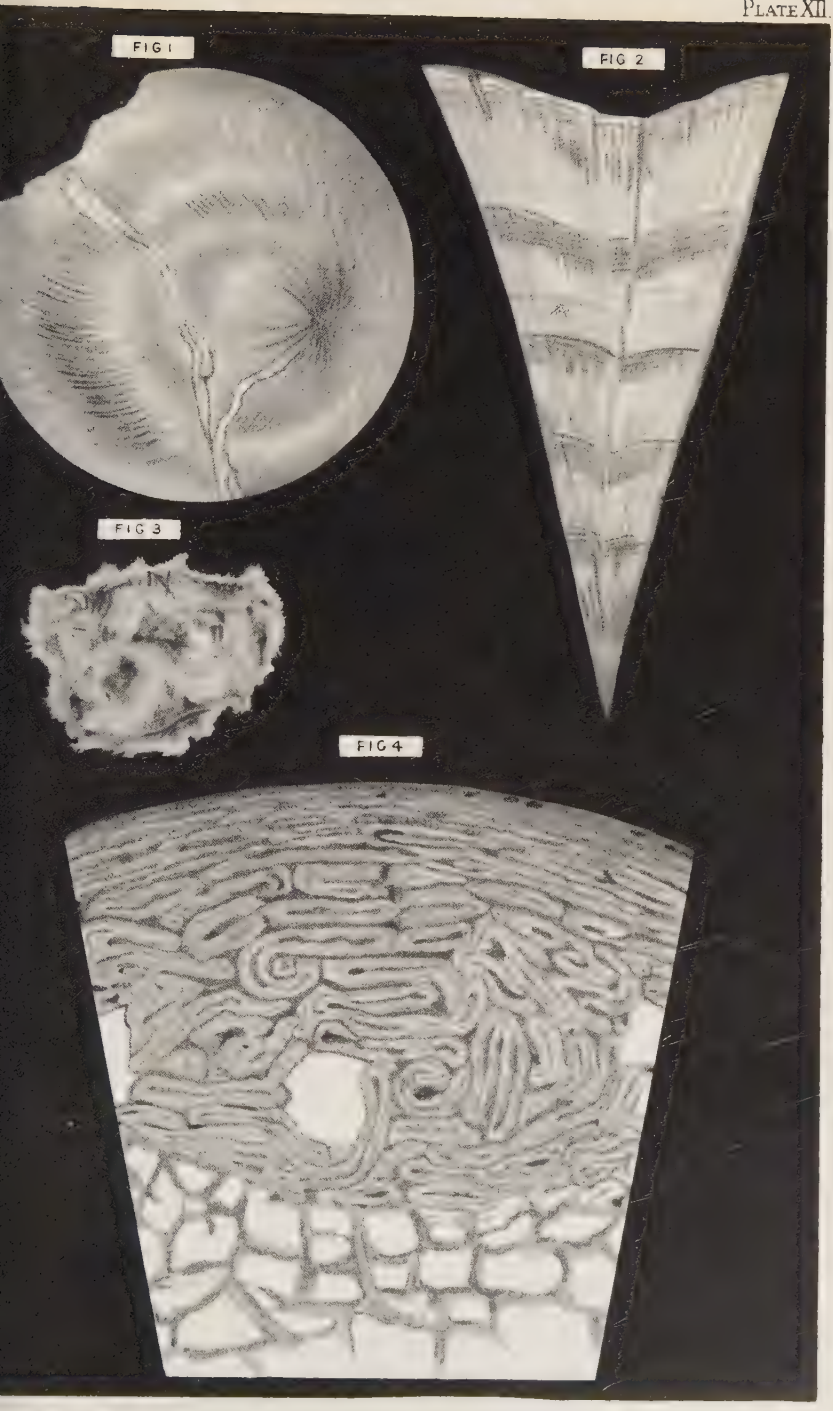




QUARTZ CRYSTALS FILLED WITH PARTICLES OF OXIDE OF TIN.

WHEAL PRIMROSE.

C. DEL.




COPIED FROM ORIGINAL COLOUR PLATE

X.—*Preliminary Notice of Substances which may prove to be New Minerals.*

By Professor Heddle.

Part Second.

Balvraidite.

I give this name to a substance which may be regarded as of the nature of a hydrated magnesian felspar.

It was found by Mr. Dudgeon and myself in granular limestone, about the third of a mile above and north-east of the hamlet of Balvraid; this hamlet is situated six miles up the Glen Beg of Glen Elg, Inverness-shire.

Only a single large mass containing the mineral was found. In this mass it was associated with blue *necronite* (orthoclase of limestones), biotite, and a hydrated labradorite.

Its colour is purplish brown of a pale cast; its structure is crystalline granular, it may be called saccharoid; its hardness is 6·; its specific gravity from 2·905 to 2·908

It varied somewhat in depth of colour, but not at all in tint. It had together a striking resemblance to *Bytownite*.

A darker and a paler variety were analysed, and gave

| | DARK | | PALE 1. | 2. |
|---|---|---|---|---|
| Silica | 46·041 | .. | 46·165 | |
| Alumina | 20·112 | .. | 20·953 | 22·282 |
| Ferric Oxide | 2·524 | .. | 1·861 | 1·951 |
| Manganous Oxide | ·784 | .. | ·843 | ·66 |
| Lime | 13·472 | .. | 13·254 | 13·925 |
| Magnesia | 8·301 | .. | 7·361 | 8·2 |
| Potash | 1·363 | .. | 1·555 | |
| Soda | 2·723 | .. | 3·252 | |
| Water | 4·705 | .. | 4·897 | 4·8 |
| | 100·025 | | 100·141 | |

The last was an incomplete analysis, the silica having been lost.

B. B. it fuses with intumescence and frothing into a vesicular and newhat pale blue glass.

Examined with the microscope, a specimen taken from the general mass owed no mixture of any other substance, and exhibited no marked

structure; having merely a mottled appearance, with a slight evidence of minute interpenetrating crystals.

The generally close accordance of three separate portions of this substance shows the uniformity of its composition.

Putting together the alumina and ferric oxide, and the potash and soda, the average composition of the three analyses becomes:—

| | | Atoms. | | Giving. |
|---|---|---|---|---|
| Silica .. .. .. .. | 46·103 .. | 15·37 | 15· | 45·32 |
| Alumina .. .. .. | 23·261 .. | 4·51 | 4·5 | 23·33 |
| Lime .. .. .. .. | 13·55 .. | 4·84 | 5· | 14·09 |
| Magnesia .. .. .. | 7·941 .. | 3·97 | 4· | 8·05 |
| Soda .. .. .. .. | 4·446 .. | 1·5 | 1·5 | 4·68 |
| Water .. .. .. .. | 4·802 .. | 5·33 | 5· | 4·53 |

These numbers, calculated from the atoms, agree fairly with the analytical results; the atoms of silica also balance those of the bases without the water. No formula can be deduced from these numbers however, without a strained grouping of the alkalies with the sesquioxides though this indeed is little more strained than the present method of grouping them with the protoxides, and the leaving of the water to stand excluded, as if it were always mere water of hydration.

## Hydrated Labradorite.

Substances of such a nature are far from uncommon: they are generally set down as resulting from partial alteration.

That presently noticed, which was associated with the *balvraidite*, has anything but an altered or weathered appearance, being remarkably fresh and even characteristic in appearance.

In colour and lustre it is like bleached wax, its structure is flat-fibrous resembling thus radiated *Cleavelandite*. Rarely some parts were granular. No cleavage angle could be measured, as the surfaces of cleavage were all curved. Its specific gravity is 2·708.

It yielded—

| | |
|---|---|
| Silica .. .. .. .. | 49·33 |
| Alumina .. .. .. | 26·698 |
| Ferric Oxide .. .. .. | ·25 |
| Lime .. .. .. .. | 11·02 |
| Magnesia .. .. .. | ·072 |
| Potash .. .. .. | 2·59 |
| Soda .. .. .. .. | 5·254 |
| Water .. .. .. .. | 4·845 |
| | 100·059 |

B.B. it frothed like a zeolite, and fused moderately easily to a transparent blebby glass.

hen heated in chips in a crucible by the more gentle action of a en burner, the chips assumed the lustre of white mica throughout; ustrous planes were small, and lay in every direction, but chiefly in s which accorded with the direction of the fibres.

ter more intense heating the mineral exfoliated much before finally g. Ordinary labradorite does not behave in this manner, and it also with more ease than this.

is mineral is noticed here in order to consider searchingly the question ier *balvraidite* can be a result of a simple combination or fusion of *te by* and *in* this hydrated labradorite.

e facts, as relates to the mode of occurrence, are that plates of *Biotite* are lded in *both* minerals.

any combination could take place between them why did it not take between the *Biotite* and its labradorite matrix? And again, if *vidite* is the result of such union how comes it that there are clear us plates of Biotite still imbedded in it?

reover, a chemical consideration will not permit of our drawing the con- n that *balvraidite* is a compound mineral so formed, inasmuch as such on of Biotite with the labradorite as would introduce so large an nt of magnesia, would at the same time reduce the lime very edly; while its quantity in *balvraidite* is, it will be observed, con- bly *greater* than what it is in the hydrated labradorite.

### Tobermorite.

s is a zeolite which I first found totally filling small druses in the of the shore immediately to the north of the pier of Tobermory in sland of Mull.

s massive, or very minutely granular; its colour is a very pale pinkish ; it is translucent; it is frequently surrounded by a thin zone of pale massive mesolite. I have never found it in any druse which was not to its centre with it, therefore I have seen no trace of crystalline . It has a hackly fracture, without any trace of cleavage.

yielded.—

| | |
|---|---|
| Silica .. .. .. .. | 46·508 |
| Alumina .. .. .. .. | 2·402 |
| Ferric Oxide .. .. .. | 1·139 |
| Ferrous Oxide .. .. .. | 1·853 |
| Lime .. .. .. .. | 33·404 |
| Magnesia .. .. .. .. | ·474 |
| Potash .. .. .. .. | 1·445 |
| Soda .. .. .. .. | ·356 |
| Water .. .. .. .. | 12·606 |
| | 100·187 |

The specimen analysed appeared quite pure, that is it contained particle of the dark matrix.

I next found the mineral in the cliffs near the lighthouse, north Tobermory, and along the shore towards Bloody Bay. In its mo of occurrence and appearance it was in all respects similar to that Tobermory. There was here no visible mesolite.

The specific gravity of specimens from this spot, which were larger t those first mentioned, though still seldom larger than a damson, 2·423.

This yielded.—

| | |
|---|---|
| Silica .. .. .. .. | 46·62 |
| Alumina .. .. .. .. | 3·895 |
| Ferric Oxide .. .. .. | ·664 |
| Ferrous Oxide .. .. .. | 1·080 |
| Lime .. .. .. .. | 33·978 |
| Potash .. .. .. .. | ·572 |
| Soda .. .. .. .. | ·891 |
| Water .. .. .. .. | 12·109 |
| | 99·81 |

In proceeding to calculate the formula of this, it is evident that (it an impurity) the alumina can only replace silica, and the ferrous-oxide h

The average of the two analyses and the calculation is as follows :—

| | | Atoms. | | P. C. |
|---|---|---|---|---|
| $SiO_2$ .. | 46·564 | 1·552 | 15· | 49·83 |
| $Al_2O_3$ .. | 3·148 | ·08 | | |
| $Fe_2O_3$ .. | ·901 | | | |
| FeO .. | 1·466 | ·04 | | |
| CaO .. | 33·691 | 1·203 | 12· | 37·21 |
| $K_2O$ } $Na_2O$ } | 1·632 | ·03 | | |
| $H_2O$ .. | 12·357 | 1·373 | 13· | 12·96 |

This gives the formula :—

$$3\,(CaO^4,\,H_2O),\,5\,SiO_2+10\,H_2O$$

The mineral thus stands intermediate between *xonaltite* and *okenite*.

It is an interesting fact that *xonaltite* occurs in several Mull localit some not far distant from the locality of *tobermorite*. This is the fi observation of *xonaltite* as a British species.

Before the blowpipe there is no reaction of this mineral which ser to distinguish it from other zeolites.

Last year I obtained it in pieces the size of a small fist, in a qua out of which the pier at Dunvegan in Skye had been built. It was h also surrounded by a zeolite—which in this case was faröelite.

he specimens here were finer, and had a more distinct pink hue. *Pyrolite* was seen in some of the adjacent cavities.

### Walkerite.

Dr. Walker, Professor of Natural History in the University of nburgh, published an analysis of a radiated yellowish-white mineral ch was found in diabase at Corstorphine hill near Edinburgh. This is first of the three analyses which stand below.

n a paper upon British *pectolites*, I introduced this analysis as belonging hese.

everal years afterwards I became the purchaser of the collection of erals amassed by Mr. Jameson Torry,—nephew of Professor Jameson Edinburgh. In this collection I found a specimen which agreed with description of Walker's mineral; this had a label attached, which bore Mr. Torry's hand-writing,—"From the great quarry, north side of torphine Hill."

took part of this specimen for analysis. The specimen was a vein, it three fourths of an inch in thickness; this vein was formed of ating and interlacing lustrous cream-coloured fibres. These fibres phoresce when heated, and also slightly when broken.

ne mineral had a specific gravity of 2·7, and it lost 1·28 per cent. of r when heated in the water-bath.

s analysis, on 21·426 grains, is given in the second column. A note appended at the time, "does not agree with pectolite." The analysis incomplete from my not wishing further to sacrifice the specimen, he hope of afterwards succeeding in getting more of the mineral.

year or two after this analysis was published, I obtained a few chips the western side of the lower top of the Bin Hill, in Burntisland. d sufficient only to determine the presence of magnesia in quantity. ext, I myself obtained it as a fine vein, of over an inch in width, in the quarry of Corstorphine Hill.

ere the vein consists of bunches of diverging fibres or flat crystals, of h almost pearly lustre, and a pinkish cream colour. The hardness is The specific gravity 2·712. It phosphoresces when broken.

ne analysis is the third column in the table.

| | | | |
|---|---|---|---|
| $SiO_2$ .. | 54· | 53·215 | 52·202 |
| $Al_3O_3$ .. | .. | ·093 | |
| FeO .. | .. | ·21 | 1·335 |
| CaO .. | 30·79 | 26·178 | 28·635 |
| MgO .. | 2·59 | 6·815 | 5·12 |
| $K_2O$ .. | .. | n. det | ·852 |
| $Na_2O$ .. | 5·55 | n. det | 6.504 |
| $H_2O$ .. | 5·43 | 5·228 | 5·276 |
| | (Walker, 98·36) | | 99·915 |

As it is evident that Walker had thrown down much of his magn along with his lime, the last analysis alone is used in the calculation atoms. It gives—

| | | Atoms | P. C. |
|---|---|---|---|
| $SiO_2$ | .. 1·74 | 7 | 53·71 |
| CaO | .. 1·023 | 4 | 28·65 |
| MgO | .. ·25 | 1 | 5·12 |
| $N_2O$ | .. ·24 | 1 | 7·92 |
| $H_2O$ | .. ·586 | 2 | 4·6 |

The formula may be written thus:—

$$7\,(CaO^4,\ MgO,\ Na_2O,\ H_2O)\ SiO_2 + H_2O.$$

I also recognised in the collection lately belonging to the Royal Societ Edinburgh, three fine specimens—veins nearly three inches in thickne gathered by Sir George Mackenzie at the Bin of Burntisland, an Corstorphine; but I could not obtain any portion of these for an when the collection was made over to the University.

There being now no question that this, although standing near it substance quite distinct from pectolite, I propose for it the nam Walkerite, after its discoverer.

From Professor Walker, who was a diligent mineralogist, Jam probably derived his first love of the science.

Walker made several discoveries which have since been credite others.

From the sixth volume of the "Edinburgh Philosophical Journal quote the following, which is probably from the pen of Jameson him

"Walker found in 1761 *strontianite*, ore, and ochre of nickel. P bum Pellucidum of Linneus, *(cerussite)*, Plumbum decahedrum, *(ce site)*, and Cyaneum *(linarite)*, both undescribed. Saxum metallifc of the Germans. Ponderosa aerata of Bergmann *(Witherite)*, and Morettum, which afterwards appeared to be a peculiar sort of zeo *(Brewsterite)*. All these were here for the first time discovered Britain.

Besides, the green, gray, and yellow ores of lead, with other mine which are rare and seldom met with in other places.

In 1764, the beautiful carnelian marble of Tirey (Tiree); the w marble of the same island, with green transparent schorl *(sahlite)*, green serpentine, and Lapis Nephriticus of Iona; the green jaspe Rume; the amianthine rock of Bernerey; and the black-lead of Glen

Examined Morvern, and the mines of Strontian. 'There I found se rare minerals, and particularly that singular substance, since called strontianite, in great plenty; though I had observed it, but very sparin three years before in the mines of Lead-hills.'

In 1771 in the mines of Tynandom nothing uncommon excepting a beau-
ul crystalline ore of zinc (yellow blende.)

Walker's collection in 1822, constructed on his arrangement, consisted
323 genera—1559 species and varieties,—with duplicates, the number
ing probably double."

The names within brackets are by the writer.

The so called strontianite of the Leadhills has been proved, by an
alysis of the writer's, conducted upon a specimen which can be distin-
ished by its weight, but not by the eye, from strontianite of Strontian,
be merely a strontiferous arragonite. This specimen was ticketed by
rry "Green Strontianite from Leadhills."

Only those who have explored such places as Rum and Berneray can
m a just estimate of the scientific zeal which must have animated the
n who did so in the year 1764.

Walker was truly the Father of British Mineralogy.

# Reviews and Notices.

*On the Carboniferous Volcanic rocks of the basin of the Firth of Fort in the field and under the microscope,* by Archibald Geikie, L.L.D.,F.R

THIS very valuable communication was read by the author to the Roy Society of Edinburgh, on the 3rd February and the 28th June, 187 It consists of 80 folio pages with many woodcuts, two plates illustrati the geology of the district, and two (beautifully printed in colours) showi the microscopic structure of the various rocks.

The first part of the memoir is stratigraphical. The author groups various volcanic rocks into six districts as follows.

1. *Edinburgh district,* including the masses of Arthur Seat, Cal Hill, &c, mostly anamesites, basalts, and porphyrites—erupted about close of the old red sandstone period.

2. *East Lothian district,* including the Garlton Hills and the coast-hi near Dunbar, mostly porphyrites and claystones—erupted all through t old red sandstone period close up to Carboniferous times.

3. *West Lothian district,* mostly basalts—as at the Binns Hil Linlithgowshire—erupted chiefly in Carboniferous times.

4. *Stirlingshire district,* including the porphyrites and dolerites, la and tuffs of the Campsie Fells and of Kilsyth—erupted in Carbonifero times and probably also in much later times.

5. *West of Fife district,* the Saline and Cleish Hills, Burntisland, & with its very distinct lava streams—probably erupted before t Carboniferous period.

6. *East of Fife district,* including the very interesting volcanic ver of the coast near St. Andrews. The author concludes this part of subject as follows.

"Taking the history of volcanic action as a whole within the basin of the Firth Forth during the Carboniferous period, we can recognise two distinct types in the occ rence of the rocks,—1st; Successive streams of porphyrite lavas were poured out u their united mass attained a thickness of sometimes more than a thousand feet. Co paratively little tuff was ejected over these areas, except here and there, in the ear stages of eruption. The lavas now form continuous sheets covering wide spaces country, and rising into conspicuous ranges of hills. This is undoubtedly the preval type of the volcanic accumulations in the Carboniferous system in Scotland. Campsie Fells in the Stirlingshire district, already described, are only the north-east

remity of the extensive volcanic plateaux of Dumbartonshire, Renfrewshire, and rshire. The Garlton Hills, in the East Lothian, form a small detached area of the ne character, and belonging to the same period; while only about 18 miles to the south- t, on the other side of the Lammermuir uplands, the great volcanic zone of Berwick- re begins with the same kind of rocks, and swells out towards the south-west into the ges of Roxburgh and Dumfries. 2nd; The other type is almost confined to the basin the Firth of Forth. It consists in the protrusion of numerous detached masses of , and of various augitic lavas never united into wide plateaux or extensive hill-ranges, all pointing to local and sporadic action. The four districts in the Forth basin where type is exhibited may, indeed, be viewed broadly as only one area lying between the districts of the Campsie and Garlton Hills, which so characteristically exemplify the t type.

The local and independent character of the volcanic activity of the second type may connected here with another feature, which cannot fail to strike the most casual erver. While the great hollow of central Scotland, between the Old Red Sandstone s on the north, and the Silurian and the Old Red Sandstone heights on the south side, tinued for fully a half of the Carboniferous period to be the scene of extraordinary anic activity, the eruptions so far as we can judge, were always confined to the valley. night be contended that possibly many sheets of tuff or of lava may have been stripped the bounding hills on either side. But the fact remains, that even were it so, these anic materials were erupted from orifices in the valley, and not on the hills. In no have I ever met with true volcanic necks on the hills on either side of the great ral valley.* Denudation could not have removed them; their absence makes it ain that the numerous volcanic vents were confined to the low grounds."

Speaking of the structure of the volcanic masses the author remarks:

"The volcanic rocks associated with the Carboniferous formations in the Basin of the h of Forth may be conveniently grouped into four sub-divisions according to their e of occurrence with reference to the surrounding strata. 1st, *Necks*, that is, masses olcanic material occupying the space of former vents or orifices out of which the anic eruptions proceeded. 2nd, *Intrusive Sheets*, *Dykes* and *Veins*. These are ions of lava which never succeeded in forcing their way to the surface, but after trating some way upward, were arrested in their progress, and consolidated among rocks. 3rd, *Interbedded* or *Contemporaneous Lavas*, that is, masses of molten rock h were emitted at the surface, flowed out there in streams, and consolidated into ts that lie conformably among the strata with which they are geologically contempor- us 4th, *Tuffs*, which occur in large stratified masses, or in small beds, either inter- tified with ordinary sedimentary deposits, or accompanying sheets of lava."

These different modes of occurrence are then described in great detail.

The second portion of the memoir deals with the macroscopic and roscopic petrography of the district in considerable detail To this of the subject the author has devoted much of his attention for twelve rs, and we have here the results of this long extended study.

The rocks are classed as Diabase, Dolerite, Basalt, Pikrite (a remarkable

* In the valley of the Nith and its tributary the Carron Water, among the high grounds of frieshire, necks belonging to the Permian series of volcanoes occur. At the head of erdale, Mr. B. N. PEACH has observed a small neck coming through the Upper Old Red lomerate, and possibly connected with the volcanic action in which the Berwickshire and burghshire porphyrites were erupted. But in these cases the orifices have been opened in valleys among the hills. [Since this was written, Mr. PEACH has met with a number of nic necks of Lower Carboniferous age in valleys of the Silurian uplands of Roxburghshire, ding to a distance of at least 10 miles from the edge of the lava-sheets.]

serpentine-olivine rock), Porphyrite, Felsites and fragmental rocks or tuff all of which occur within the area in question. This second part Professor Geikie's memoir should be carefully studied by all petrographer

J.H.C.

*Crystallized Danberite*, (G. J. BRUSH & Ed. S DANA, *Am. Journ. Sc* Aug. 1880). This is a memoir in which the mode of occurrence, crystal lographic and chemical characters, optical properties and chemical com position of the danberite of Russell, St. Laurence Co., New York, a described in considerable detail. The form is orthorhombic and ver similar to topaz, the axial ratios being as under:—

| | *c* (vert) | *b* | *a* |
|---|---|---|---|
| Danberite .. | 0·8830 | 1·8367 | 1·0000 |
| Topaz .. | 0·9024 | 1·8920 | 1·0000 |

Seven figures of crystals are given. Some of the crystals are of co siderable size, the largest is 4 inches long and 2½ inches wide.

H = 7 to 7·25; G 2·986 to 3.021, lustre of crystalline surfaces brillia on fractured surfaces vitreous to greasy; colour pale wine-yellow yellowish-brown; cleavage basal but not very distinct; fracture une to sub-conchoidal. B.B. fuses at 3·5 to a colourless glass, tinging t flame green, the bead is milk-white on cooling; in matrass phosphoris on heating with a reddish-yellow light; slightly acted on by HCl, gel tinizes readily with HCl after heating. The following is the mean four analyses.

| | |
|---|---|
| Silica .. .. .. .. | 48·23 |
| Boron trioxide .. .. .. | 26·93 |
| Lime .. .. .. .. | 23·24 |
| Alumina .. .. .. .. | ·47 |
| Ignition .. .. .. .. | ·63 |
| | 99 50 |

Agreeing very well with the formula $Ca\ B_2\ Si_2\ O_8$. J.H.C.

*On the theory of Twin Crystals.*—G. TSCHERMAK, (*Min. u. Pet. Mit* II. 6. p. 499.) This paper consists of a hypothetical examination the mode in which twin crystals may be produced, starting from th molecules of the crystals. The author deduces the following theoretica results from his inquiry.

The origin of a true twin crystal is occasioned by two molecules whic cohere before they have been able to take up positions of perfect symmetry the arrangement being such that they have one plane of symmetrica position, and one axis of symmetry lying in that plane-parallel. Tw

lecules possessing parallel lines of symmetry, but which do not corres-d in their lines of growth, form interpenetration twins (like the inter-etrating tetrahedra of Fahlerz, &c.)

n true twin crystals the two molecules stand to each other in hemitrope itions, i.e. one is turned through 180°, but in interpenetration twins they parallel.

All true twins have their molecules symmetrical to a crystallographically erminate plane, whilst interpenetration twins behave like parallel regates. The mechanical production of twins of calcite may be lained by the semi-revolution on the twin axis of the molecules that e been acted on by pressure.

The chief laws regulating the forms of twin crystals are :—

Twin crystals are aggregates of two individuals, which are not completely allel, but are so placed as to have at least one possible similar plane one edge lying in that plane parallel in each.

There are three forms of twins according as the two individuals have the edges in the above plane parallel, or have the entire zone of which edge and plane form part, parallel, or merely satisfy the above general dition.

A hemitrope position is a necessary condition of true twin crystals.

The axis of revolution is either perpendicular or parallel to a possible ne of the crystal ; in the latter case it is either parallel or perpendicular possible edge.

Twins of parallel sided individuals are either directly or after suitable allel displacement symmetrical to a plane which is either parallel or pendicular to a possible plane of the crystal, being in the latter case parallel or perpendicular to a zone.

Twins of individuals with inclined sides are usually asymmetrical. If wever the two individual crystals are imagined as being holohedral, the responding twin crystal would be symmetrical.

Regular aggregates of crystals obey laws similar to those of twin crystals.

H. L.

*Mineralogical Notes* by Carl Vrba, *(Czernowitz)* (*Zeitsch. f. Kryst. u. ., P. Groth* IV. 4*).—Vanadinite from the Obir, Carinthia.*—The thor has re-determined the angular elements of this mineral, there being onsiderable discrepancy between the previously obtained results of nmelsberg and Schabus. The author finds the angle $10\bar{1}1 : 0001$ (0P) = 39°·25′56″, whence c = 0·712177, thus agreeing closely with results of Schabus; he moreover records in specimens from the above ality the forms $(10\bar{1}2)$ $(30\bar{3}1)$ $(21\bar{3}0)$, which have not hitherto been iced in Vanadinite.

H.L.

*Miscellaneous contributions to Microscopic Mineralogy.*—By H. FISCHER (*Freiberg i. B.*) (*Zeitsch f. Kryst. u. Min., P. Groth.* IV. 4.)—This paper contains the record of a series of microscopic examinations of various minerals, in many of which the author finds more or less impurities producing variations in the formula of the mineral, e.g. minute cubes of iron pyrites in berthierite. The following is a list of the minerals examined: berthierite, chrome iron ore, incrustations of blende (which proved to be wurtzite), klipsteinite, karpholite, krokydolite, augite from Sicily, beauxite, isopyre, aphrodite, stilpnomelane, lazurite, jadeite, fayalite, monazite, svanbergite, cryptolite, kakoxene, arseniosiderite, and aluminite.

H. L.

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*Hannayite and Newberyite*, by McIVOR, (*Melbourne,*) *Sitzungsber. der Nieder-rhein, Ges. f. Natur. u. Heilk., January* 1879. (*previously noticed in this Mag. Vol.* III *p.* 108.)—Hannayite occurs in the guano of the cave at Skipton, near Ballarat. The crystals are 10-12 m.m. long and 1-2 m.m. in thickness. Triclinic:

$$a : b : c = 0{\cdot}6990 : 1 : 0{\cdot}9743.$$
$$a = 122°31' \quad \beta = 126°46' \quad \gamma = 54°10\tfrac{1}{2}'.$$

The forms that have been observed are: (100) (110) $(1\bar{1}0)$ (001) and $(\bar{1}\bar{3}3)$. Cleavages occur parallel to 001, 110, $1\bar{1}0$, and 130. Color pale yellow. Specific gravity 1·893.

Analyses:—

| | | | |
|---|---|---|---|
| $P_2O_5$ .. .. .. .. | 45·63 | .. .. .. | 45·77 |
| MgO (with trace FeO) | 18·72 | .. .. .. | 19·08 |
| $(NH_4)_2O$ .. .. .. | 8·19 | .. .. .. | 7·99 |
| $H_2O$ .. .. .. .. | 28·12 | .. .. .. | 28·29 |
| | 100·66 | | 101·13 |

This composition corresponds to the formula:

$$Mg_3P_2O_8 + 2(NH_4)H_2PO_4 + 8H_2O.$$

*Newberyite*, from the same locality as the last mineral, discovered by C. Newbery; it occurs in large tabular crystals. Rhombic system:

$$a : b : c = 0{\cdot}9435 : 1 : 0{\cdot}9299.$$

Observed forms: (100) (010) (001) (111) (102) (021), the plane of cleavage being 010.

The following is an analysis of the mineral:

| | |
|---|---|
| $P_2O_5$ .. .. .. .. .. | 41·25 |
| MgO (with trace of MnO) .. | (23·02) |
| $H_2O$ .. .. .. .. .. | 35·73 |
| | 100·00 |

The formula is therefore $Mg_2H_2P_2O_8 + 6H_2O$. H. L.

*n an artificial silicate resembling Orthose*, by C. Friedel *and* E. Sarasin, *ll. d. l. Soc. Min. d. France* III, 1.)—The authors heated strongly a ture of silicate of alumina, silicate of potash and water in an imperfectly d tube, so that the water escaped at an elevated temperature. On ting the dry residue with hydrochloric acid, there remained a coarse der, consisting of nacreous crystalline plates, which, on measurement, ared to be Orthose; small crystals of quartz were also produced in experiment.

H. L.

*n the separation of heavy microscopic minerals*, by René Bréon. (*Bull. Soc. Min. d. France*, III, 3.)—In order to separate minute particles eavy minerals, of different specific gravities, from each other, the or proposes to employ a mixture of the fused chlorides of lead and the respective specific gravities of these two liquids being 5 and 2·4, hat by properly proportioning the mixture, any two minerals, of rent specific gravities, but lying within the above limits, can be rated. The fine powder, to be experimented on, is thrown into the l chlorides, contained in a conical glass tube, when the particles lily come to rest, some floating, and the others sunk at the bottom e tube; the mass is then allowed to cool, and when set, the tube is ged into cold water, thus cracking the glass. The upper and lower ons of the mass of chlorides containing the minerals can then be ved, and the chlorides dissolved out with water acidulated with ochloric acid.

H. L.

*Pseudomorphs.* F. E. Geinitz (*Min. u. Pet. Mitt., G. Tschermak.* . p. 489.) The author maintains his views on the systematic classi- on of pseudomorphs against those of R. Blum, and proposes the ving subdivisions:—

Classification of pseudomorphs according to the chemical processes eir formation:

(1.) Pseudomorphs produced without loss or gain of components.

(2.) Pseudomorphs produced by loss of components.

(3.) Pseudomorphs produced by gain of components.

(4.) Pseudomorphs produced by exchange of components, in which the connection between the constituents of the original and the pseudomorphous minerals is still capable of demonstration.

(5.) Pseudomorphs produced by exchange of components, but wanting the above mentioned connection.

II. The following stages were passed through by each of these pseud morphs in the process of its formation :—

(1.) Envelopment in some medium that preserved the extern form ; such envelope either being furnished by
  a. Some foreign substance or incrustation,
  b. Some process of change producing a crust of decom posed mineral, or else it was already present in the
  c. Original envelope or matrix.
  d. In certain pseudormophs, namely paramorphs, an e velope may have been rendered unnecessary by the stron tendency to crystallise ("Krystallisations-Tendenz") the original mineral.

(2.) Solution and extraction of the original mineral, and almost contemporaneous, or an afterwards occurring

(3.) Replacement by new substance ; either by
  a. Continuation of the already commenced decomposit or by
  b. Infiltration, more or less independent of the deco position.

These three stages of formation may either follow each other closely they may suffer interruptions.

The author holds that there is no true displacement of mine substance, and objects to the term "displacement pseudomorph ("Verdraengungs-Pseudomorphosen) of Blum, preferring "excha pseudomorphs" ("Austauschs-Pseudomorphosen.")

He finally suggests the following names for the five classes, defined the beginning of his paper.

1. Paramorphs.
2. Apomorphs.
3. Epimorphs.
4. (4. a.) Partial allomorphs (= a contraction for allassomorphs.)
5. (4. b.) Complete allomorphs.

H. L.

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PECKHAMITE (J. L. SMITH, *Am. Jour. Sci., Aug.*, 1880).—This occ in the Emmet County Meteorite. It has a fused surface of a dingy-yell colour ; when broken, it has a greasy aspect with traces of cleavage, a the yellow colour has a greenish hue ; G.=3·23. Analysis as follows:

| | | |
|---|---|---|
| Silica .. .. .. | 49·50 | 49·59 |
| Ferrous Oxide.. .. | 15·88 | 17·01 |
| Magnesia.. .. .. | 33·01 | 32·51 |
| | 98·39 | 99·11 |

This agrees with the formula 2 $\ddot{S}i\,\dot{R}+\ddot{S}i\,\ddot{R}_2$ "being two atoms of ens tite or bronzite plus one atom of olivine." J. H. C.

NTARIOLITE (C. U. SHEPHARD, *Am. Jour. Sci., July*, 1880).—This is neral hitherto taken to be Scapolite, but Prof. Shephard finds it differs nically from Scapolite. H=7 to 7·5 ; G=2·608 ; resinous to vitreous ; ains several per cents of organic matter. Powder very feebly acted on strong acids. It occurs in small crystals embedded in bluish-grey harine limestone and looks like chiastolite. Chemical analysis gives following results :—

| | |
|---|---|
| Silica .. .. .. .. | 48·65 to 51·30 |
| Alumina .. .. .. | 13·45 to 19·62 |
| Lime .. .. .. .. | 17·43 to 21·60 |
| Titanic Oxide .. .. | 4·35 to 5·21 |
| Soda .. .. .. .. | 4·35 |
| Potash .. .. .. .. | 1·109 |
| Magnesia .. .. .. .. | ·468 |

J. H. C.

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ASSITERITE (*ibid*).—This occurs at Corsa, Alabama, in crystals smaller a pea with fragments and grains of tantalite ; one crystal of Yttro- alite was also observed.

J. H. C.

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ARACOLUMBITE (*ibid*).—Prof. Shephard proposes to name the Para- mbite from Taunton, Mass., Para-ilmenite, since it has "no chemical ion to Columbite.

J. H. C.

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TAUROLITE (*ibid.*)—Hemihedral forms of this mineral have been found Lorganton, Georgia, U.S.A.

J. H. C.

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ERGUSONITE (*ibid*).—This occurs with Samarskite at Mitchell Co., h Carolina, and is "identical with Rutherfordite."

J. H. C.

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AGODITE (*ibid*).—This occurs of a fine-green colour in Georgia, U.S.A. probably forms a stratum of considerable dimensions in a mica-slate ation." It often encloses copper-red rutile. H=3, G=2·86. B.B. s white and suffers slight fusion ; with borax an apple-green bead. lysis gave :—

| | |
|---|---|
| Silica .. .. .. .. .. | 48 to 52 |
| Alumina .. .. .. .. | 22·6 to 34 |
| Ferrous Oxide .. .. .. .. | 2·10 |
| Soda .. .. .. .. .. | 5·12 |
| Potash .. .. .. .. .. | 4·43 |
| Water .. .. .. .. .. | 3·50 |

mium and titanium not determined.

J. H. C.

PANDERMITE (C. G. WARNFORD LOCK, *Jour. Soc. Arts*, *Aug.* 6. 188
—This is a hydrous borate of lime occurring in considerable quantity ov
a large area near the port of Panderma on the Asiatic shore of the Sea
Marmora. "It occurs in a stratum at the bottom of an enormous bed
gypsum—has been proved for a vertical distance of 45 feet. The miner
exists in closely packed nodules, of very irregular size and shape, and
all weights up to a ton.... In outward appearance it closely resembles
snow-white fine-grained marble." J. H. C.

## Obituary.

HENRY LUDLAM.—Again we have to record the loss of an origin
member of the Mineralogical Society, in the person of Mr. Hen
Ludlam, F.G.S., who died on the 23rd of June, at the age of 58.

Early a student of the natural sciences, that of Mineralogy became
favourite subject, in which he was greatly assisted by the study
chemistry, which occupied many of the leisure evening hours which
care of an important business allowed him. Aided by an unusually criti
judgment he gathered together a large and valuable collection
minerals in which some of the species were conspicuous for th
perfection of crystalline form. To these he subsequently added
well-known and important collection which belonged to the late M
Charles Hampden Turner, of Rooksnest, Surrey; and also that made
the late Mr. William Nevill, F.G.S., of Godalming. The whole for
certainly the most complete and probably the finest collection of miner
ever made by a private collector. It is now the property of the natio
having been left to the Museum of Practical Geology, Jermyn Stre
London.

But Mr. Ludlam was not the mere collector. He had long had in vie
the desirability of preparing a complete descriptive and crystallograph
catalogue of that which it had been his good fortune to accumulate. Th
great work, to which he looked forward as to a labour of love, was actual
commenced by him shortly before the illness which ended in his prematu
death. The science of mineralogy has thus lost an earnest worker, wh
his personal friends have to lament the loss of a warm-hearted and tr
English gentleman. T. D.

W. W. STODDART, F.G.S., F.C.S., F.I.C., &c., Public Analyst for t
city and county of Bristol and the county of Gloucester, died of he
disease at his residence, Sneyd Park, Bristol, on the 30th of May la
aged 57. Mr. Stoddart was one of the original members of this socie
and he contributed a paper, "on the occurrence of Celestine in the Keu
marls, and its influence on the composition of plants"—to the first num
of the Mineralogical Magazine. J. H. C.